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Sources within sources: The dynamic influence of multiple documents trustworthiness when evaluating and using an embedded source

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Abstract
The thoughtful use of information sources to assess the trustworthiness of documents has been highlighted as a metacognitive strategy when reading complex or little-known topics on the internet. Prior studies indicate that readers can use document sources (i.e., metadata about the document) to ponder their evaluation of other sources embedded in those documents (i.e., entities referred to in the text as the origin of an idea). This study aimed to expand on those findings by examining the dynamics of such evaluations and the use of information provided by a single source when embedded in multiple document sources, which can vary (or not) in trustworthiness. Seventy-seven undergraduates, $M = 23.84$ years, read two texts on a health topic to write an essay. Each participant read the texts in one of four sequences that determined the trustworthiness of the document sources and their order of presentation. High-trust document sources were referred to more often in written productions than low-trust sources, and the information they provided was considered better than information in low-trust document sources. Additionally, the trustworthiness evaluation of the embedded source did not change when both document sources presented similar trustworthiness levels. In contrast, when trustworthiness varied across documents, the evaluation of the embedded source fluctuated: it increased when last mentioned in a high-trust document, and it decreased when last mentioned in a low-trust document. These results are interpreted in terms of the complex dynamics of reader-guided processing and, specifically, source-guided evaluations.

Keywords Critical reading · Evaluation · Sources · Trustworthiness

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Introduction

The widespread availability of the internet has presented modern readers with the challenge of sifting through reliable and unreliable documents (Britt et al., 2019). Navigating the digital realm has become increasingly complex due to the improvement in quality of generative AI, deepfakes, disinformation, and even well-intended but partial texts on intricate debates, like healthcare decision-making or postmodern warfare, among other socio-scientific discussions (List et al., 2020; Smith et al., 2024). As a result, readers must approach online content with a critical mindset when required to make informed decisions.

From a cognitive perspective, internet-based reading has been described as a problem-solving activity: to purposefully use acquired information, readers must make several choices regarding what to read, when to stop, and whether (and how) to evaluate what they are comprehending (e.g., Britt et al., 2022). Given the nature of digital reading, metacognition becomes crucial as it sets the foundation of complex and purposeful reading strategies (Cho et al., 2018). On a broad sense, text comprehension strategies refer to reader-initiated efforts to modify and elaborate on meaning construction during reading (Anmarkrud et al., 2014). In this frame, metacognition can be defined as a set of self-directed strategies, such as monitoring or planning, associated to the knowledge and control of one's own cognitive processes (Schraw & Moshman, 1995).

The role of metacognition in traditional reading comprehension scenarios has been thoroughly examined (McKeown & Beck, 2009). Newer reading contexts, such as the vast and hyperlinked environment of the internet, has highlighted the need of monitoring self-comprehension and the state of the reading goals (Afflerbach & Cho, 2010; Stadtler & Bromme, 2007). For example, monitoring (i.e., keeping in mind the task purpose and re-reading or paying attention to the more relevant or difficult segments) is a good predictor of comprehension performance in hyperlinked e-learning scenarios (Burin et al., 2020), and correlated with the acquisition of knowledge during internet research tasks (Stadtler & Bromme, 2004). Self-regulated learning and metacognitive strategy-use are also relevant for trustworthiness evaluations, helping to sort facts from fiction in the digital milieu (Denton et al., 2020).

In particular, the present work focuses on evaluating the quality of what is read, recognized as a core component of digital literacy. For example, when reading about health on the internet, a passive stance towards the information can increase the threat of making decisions and actions based on fake or faulty recommendations (Chou et al., 2021; Swire-Thompson & Lazer, 2020). A more controlled monitoring of a document's characteristics may help avoid these risks. However, this analytic process is affected by the reader's prior knowledge (McCrudden, 2020; Richter & Maier, 2017). Consequently, while an expert physician may easily assess the quality and reliability of health-related documents, laypeople might find it overly challenging.

Used purposefully (i.e., in a metacognitive, deliberate and conscious process), sources can compensate for the lack of knowledge required to assess the validity of content claims when trying to organize a coherent representation based on multiple texts (Britt et al., 1999; List et al., 2017; Stadtler & Bromme, 2014). Nonetheless, there is still much to learn about how sources are critically evaluated and used under specific reading situations.

In this work, we draw from the formal difference between a document's metadata (e.g., publisher or date) and characters cited in the body of a document as the origin of a statement (Strømsø et al., 2013). Specifically, we aimed to examine whether different layers

of source information influence each other when critically reading about unfamiliar health topics.

Source use in trustworthiness evaluations

Sources encompass a set of parameters that refer to the origin of a written text or content. These include features such as authorship, context, date, and motives behind the publication, among others (Braasch et al., 2018). Typically, these parameters converge into a social entity identified as the source agent, such as the publisher, author, divulgator of the content (Goldman & Scardamalia, 2013).

Source information can play a decisive role in the analytic process of evaluating information trustworthiness (Stadtler & Bromme, 2014). Here we will define trustworthiness evaluations as an epistemic activity, consisting of assessing whether the source has the competence, integrity, and intentions to share reliable information (Hendriks et al., 2015; Sperber et al., 2010). When given attention, trust-related source characteristics influence what readers come to consider as trustworthy or valid information and how they use it later (e.g., Kobayashi, 2014; Rouet et al., 2020).

Since the notion of source can refer to different entities, formal distinctions are usually made for bibliographic purposes. For example, according to the originality of the information, a source can be either primary (i.e., first-hand accounts of new ideas or events) or secondary/tertiary (i.e., accounts that synthesize, organize or analyze information already available). Other classification criteria include the physical nature of the source (documentary, non-documentary), the publication medium (print, electronic), or the purpose of use within the research (Ganaie & Khazer, 2015). In this work, we focus on the distinction between layers of sources concerning the text (Strømsø et al., 2013).

According to this last distinction, a source can take the form of metadata or document information, that is, data outside the text, or information embedded within a text, such as a scholar quoted in an article (Strømsø et al., 2013). For example, picture an undergraduate writing an essay about a complex health issue and its consequences. When reading a scientific journal, the recommendations of an expert physician may be considered trustworthy. However, the same expert providing an identical explanation may be deemed untrustworthy if the information is accessed through the social media of a pseudo-scientific organization. In our example, the scientific journal and the social network are document sources (DS, hereinafter), defined as the communication platforms where something is being published. In turn, the expert is an embedded source (ES, hereinafter), defined as an agent included in the text that conveys information.

Being directly woven into the text, ES may differ from DS in different aspects. For example, ES can serve as justification and evidence for the claims being made in the DS. This creates a foundation for the argument and may allow the reader to evaluate the trustworthiness and accuracy of the information (Tabak, 2018). Nonetheless, given that ES may be included to shape a specific narrative, it could also be used to promote a sided analysis of the document. Strømsø and Bråten (2014) emphasize that readers of multiple expository web documents should be cognizant of these potential subtle connections among different source layers. However, their empirical findings led them to hypothesize that readers may struggle to distinguish between these layers, potentially evaluating the trustworthiness of a document and the embedded sources as equal.

From a psychological perspective, the formal distinction between external and embedded sources is relevant as text comprehension theories have proposed that sources are represented separately from the mental model of the text(s), with the source-content integration depending on specific rhetorical links constructed by the reader (Britt et al., 1999; Perfetti et al., 1999). Therefore, building such links requires a reader to represent sources as more than just text information, regardless of their location concerning the text. Specifically, how characters are presented and their role in the text may alter whether they are represented as sources. For example, sources described as close to an event in terms of space, agency and time are more easily remembered than those far in such terms (De Pereyra et al., 2014). Similarly, characters giving information about the situation depicted in a text are more likely to be represented as sources than those in the story but not acting as information providers (Saux et al., 2021).

According to Strømsø et al. (2013), layers of source information may be represented in three ways. First, embedded sources may not be represented as sources in a strict sense, that is, as information providers external to the state of affairs depicted in the text. Instead, they may simply be represented as characters within the situation model. Second, readers may represent only the embedded source, detached from the first source layer (i.e., the DS). Third, readers may use the document information to contextualize the references and information provided by the embedded sources. In cognitive terms, this last alternative would imply the most complex alternative, as it involves using the DS to contextualize the ES, offering a more comprehensive framework to validate the claims made in the text.

A handful of studies have examined whether readers detect and use source layers when performing comprehensive reading tasks (Anmarkrud et al., 2014; Bråten et al., 2016; Salmerón et al., 2018, 2020; Strømsø et al., 2013; Strømsø & Bråten, 2014). When using a think-aloud protocol while reading texts with information about document and embedded sources, readers paid attention to both source types to some extent, but their awareness levels varied across text types (e.g., science magazines, newspaper, textbooks; Anmarkrud et al., 2014; Strømsø & Bråten, 2014). Additionally, participants' written productions after reading contained more citations to external sources than to sources embedded within the text. It is noteworthy that most of the references to embedded sources (62%) were detached from their document source suggesting that readers struggled to integrate different source layers (Strømsø et al., 2013).

In contrast to these findings, Bråten et al. (2016) reported very low memory for and usage of both document and embedded sources, even when provided with cues. Another study tested differences in sourcing between real texts vs. printouts (Salmerón et al., 2018). The results indicated that references to document sources in post-reading essays increased for real texts as compared to printouts, whereas embedded sources did not, potentially due to enhanced multisensory cues for the document source (in the real text) than for the embedded source (Salmerón et al., 2018). Similarly, after an intervention aimed at promoting sourcing, Salmerón et al. (2020) reported that the number of cited document sources increased in post-reading written productions, while the number of embedded sources' citations did not. Additionally, participants spent less time reading pages from untrustworthy document sources after the intervention, suggesting reduced attention to them.

More recently, Kiili et al. (2023) tested the factorial structure of credibility evaluations by adolescents when reading online texts. Each student evaluated four texts, one at a time, based on the author's (i.e., embedded source) expertise, benevolence, and the quality of presented evidence. Importantly, each text included information about its document source (conceptualized as text genre by Kiili et al.). After comparing four factorial alternatives, the model that best fitted the data proposed that credibility evaluations of the embedded

authors were contextualized by type of document source, suggesting a modulation of the embedded authors and their claims' evaluation by pragmatic knowledge about texts' social functions.

Overall, these antecedents indicate that readers can pay attention to source information, whether document or embedded, but they do not always do so. Additionally, they suggest that the way in which the information is presented, and the accompanying reading instructions can distinctively affect attention to source layers.

Recently, we examined how undergraduate students worked with multiple documents about a rare genetic condition (Londra & Saux, 2023). Our objective was to determine whether the trustworthiness of the document source layer would impact the trustworthiness evaluation of the embedded source, and the use of the provided information, a so-called *linked trustworthiness* effect. That study, which served as a basis for the original research reported in this work, entailed two experiments (Exp.1: $n = 27$, age $M = 20$ years; Exp.2: $n = 104$, age $M = 25$ years) that shared the same tasks and instructions. However, the second experiment was preceded by a brief pre-training to prompt source attention and use. The instructions asked the participants to read a pair of texts about treatments for a rare disease and to write an essay on which treatment they considered the best. These texts included information about the DS' trustworthiness (high vs. low) and the ES (i.e., a character described by their name, occupation, and workplace) who recommended a distinct treatment. After completing their essays, the participants rated the trustworthiness of the document sources (i.e., manipulation check) and the embedded sources on a scale of 0–10.

The results from Londra & Saux (2023) revealed that the treatments included in high-trust DS were preferred over the low-trust DS treatments in the essays, and that the perceived trustworthiness of the DS influenced the trustworthiness of the ES, so that the latter increased when the trustworthiness of the former was high and decreased when it was low. This effect was clearer in Experiment 2, which included a pre-training phase that helped to align the trustworthiness evaluation criteria among participants.

In sum, the initial evidence (Londra & Saux, 2023) supports the idea that the available information of sources in one layer can influence the evaluation of sources in another layer. Nonetheless, whether this linked trustworthiness effect is stable across reading situations remains unanswered. In fact, source-guided evaluations have been described as dynamic in nature, varying as a function of reading contexts (e.g., reading for academic vs personal motives, Schoor et al., 2024; reading goals, Porsch & Bromme, 2011), formal characteristics of a document (book vs print-out; Salmerón et al., 2018), of how results of an online search are displayed (e.g., grid vs list of search results; Kammerer & Gerjets, 2014), the presence or absence of genre-specific features (e.g., Bromme et al., 2015; Rieh, 2002), content features (e.g., situational discrepancies, Braasch et al., 2012) and even whether sources of multiple documents are dissimilar in trustworthiness (Abel et al., 2024; Thomm & Bromme, 2016).

Based on the idea of sourcing as a situational, self-regulated, dynamic process, our specific interest was to extend the results in Londra & Saux (2023) to test the idea that the perceived trustworthiness of an ES would change after reading it in a second document, whose reliability parameters differ from the first document. Prior knowledge about sources' reputation can influence what information to use during evaluative web-based tasks (e.g., Rieh, 2002). Similarly, providing credibility information about embedded sources can modify predictive inferences for future actions in subsequent passages, at least when explicit instructions and prompts are given (Sparks & Rapp, 2011). Therefore, we assumed that reading a document with an ES could lay the foundation for future encounters with documents that contain the same ES. In particular, the questions that guided the present

research were: a) are readers sensitive to source layers (DS and ES) when using and evaluating the trustworthiness of multiple documents? (as observed in Londra & Saux, 2023); and b) does this effect change when reading the same ES in more than one DS contrasting (or not) in trustworthiness? To the extent of our knowledge, whether or how reading order and sources' repetition impact trustworthiness evaluations has yet to be inspected, at least in the context of multiple documents comprehension research.

Rationale

We aimed to replicate and extend the effect reported by Londra & Saux (2023), which revealed that the perceived trustworthiness of document sources influences the evaluation of embedded sources. Specifically, the objective was to determine whether said linked trustworthiness effect would prevail when reading the same embedded source in multiple documents with similar or discordant levels of trustworthiness.

Our research hypothesis was that the trustworthiness of the document source would influence the evaluation of the embedded source (as in Londra & Saux, 2023), and that this influence would change when reading the same embedded source in a new document. In consequence, we formulated the following specific hypotheses:

- H1: The trustworthiness evaluation of the ES is a dynamic process that will adjust to the current reading context (i.e., the DS). In particular, the trustworthiness levels of an embedded source will remain high after reading it in a homogeneous sequence of two high-trust (HT-HT) documents (H1a), and low when embedded in a homogeneous low-trust (LT-LT) sequence of documents (H1b). In contrast, trustworthiness levels will increase after reading it in a mixed sequence starting with a low-trust document and finishing with a high-trust document (LT-HT; H1c), and decrease in a reversed mixed sequence, that is high-trust and low-trust document (HT-LT; H1d).
- H2: Discrepancies in content and source characteristics have shown to promote attention to sources and their use in post-reading tasks when comprehending multiple perspectives (Braasch et al., 2012; Braasch & Kessler, 2021). Thus, mixed sequences (HT-LT and LT-HT) should elicit more references to DS (H2a) and ES (H2b) in the essays, in comparison to homogeneous sequences (HT-HT and LT-LT).
- H3: in line with our prior results (Londra & Saux, 2023), participants should side with the arguments of the ES in the context of a high-trust DS. Due to the nature of the present manipulation, we expected to observe this preference in mixed sequences, which include both high- and low-trust DS (H3). For homogeneous sequences, in which trustworthiness was similar across DS, we did not expect the preference for an argument to vary as a function of the manipulation.

Method

Participants

Seventy-seven psychology and psychopedagogy undergraduates from a large public university in the metropolitan area of Buenos Aires (Argentina) volunteered as participants (Age $M = 23.84$, $SD = 7.50$, 63 female and 14 male). Students were recruited by visiting

their classes and inviting them to participate. Those who volunteered were contacted later to coordinate the time and date of the experiment. All of them were in the first half of completing their degree and were native Spanish speakers. Informed consent was requested before participation. The self-report of prior knowledge of the disease (i.e., cystic fibrosis) showed low scores, $M = 1.39$, $SD = 1.89$ on a 0–10 scale. The study followed the Argentinean Scientific and Technological Research Council ethical guidelines for social science research (Resolution nr.: 2857/2006; CONICET, 2006).

Materials

Pre-training

To promote source evaluations while reading, a brief pre-training (up to 25 mins) was held before the experimental tasks (adapted from Pérez et al., 2018; for details see Londra & Saux, 2023). First, the training introduced three cues of source quality (i.e., author characteristics, motivations, and media quality). Then, the participants were presented with examples of internet documents (about an infectious disease outbreak, food quality, and effects of stressful work environment) and were encouraged to reflect on the quality of the documents by applying the provided cues. Finally, they were asked to select from lists of 3 sources (varying in expertise) the most reliable to get information about technology and education. While completing these activities, participants were encouraged to provide real-life examples. The pre-training aimed at prompting source attention and homogenizing evaluation criteria in the sample. However, it did not include any reference to the manipulation (i.e., the existence of source layers and the combined use of these layers).

Texts

Two texts regarding treatments for a rare genetic disease were adapted from Londra & Saux (2023). The texts were constructed specifically for research purposes from online information about cystic fibrosis and its treatments. Several versions of the texts' components (DS, ES and additional information) were empirically pre-tested in terms of trustworthiness (for details see Experiment 1, section Preliminary Testing in Londra & Saux, 2023). The final versions of the texts were similar in length (160 vs 175 words), structure, and readability (both "somewhat difficult" according to the Fernández Huerta index, an adaptation to Spanish from the Flesch index that ponders the number of syllables per word and the number of words per sentence to stablish the ease of reading of a text, Fernández, 1959).

Both texts started with a header with information regarding a DS. This section included the name of a fictitious publication, and a brief description designed to suggest either high or low trustworthiness. Next, the first paragraph of each text included a description of the disease (i.e. cystic fibrosis) highlighting its complex and polysymptomatic nature. The second paragraph introduced the ES, which was the same for both texts. The ES was described by providing a name, occupation, and workplace designed to be perceived as mid-range in terms of trustworthiness. Embedded Source's trustworthiness was pretested by asking a group of 120 volunteers to rate 14 ES in terms of how trustworthy they were to provide health recommendations related to the experimental texts' topic (10-point scale). The ES varied in expertise, first-hand knowledge, and pertinence. The objective was to find a pertinent ES with scores around 4 to 6 (i.e. neutral in terms of trustworthiness). The selected ES (i.e., a nurse in a pulmonology service) obtained mean scores of 5.96, $SD = 2.42$. The

pretesting sample was similar in age and studied in the same university as the participants who completed the experimental tasks reported in this work (for more details, see Londra & Saux, 2023). In each document the same ES presented a different treatment (i.e., physical activity or dietary changes) and explained their benefits. Treatments were presented as good options among others, so that there was no flagrant contradiction between the two source statements. The last paragraph provided epidemiological information and closed stressing the importance for parents and health care providers to stay informed about the disease.

DS parameters could vary in trustworthiness across texts. This was accomplished by providing information about media quality, author motivations, and access to experts (criteria adapted from Pérez et al., 2018). The high-trust DS was depicted as having a strict editorial filter, benevolent motivations, and access to expert authors, whereas the low-trust DS was described as having a less strict editorial filter, ideological biases, and poor or no expert support. Table 1 presents examples of the texts.

Design

The main manipulation (between subjects) was the sequence of presentation of the documents (Presentation Sequence). Some participants would read both texts framed within DS of homogeneous trustworthiness and others within DS of contrasted trustworthiness. The first Sequence presented two texts with high-trust DS (HT-HT homogeneous sequence) and the second two with low-trust DS (LT-LT homogeneous sequence). The third sequence presented the first text with a high-trust DS and the second text with a low-trust DS (HT-LT mixed sequence). Lastly, the fourth sequence presented the first text with a low-trust DS and the second one with a high-trust DS (LT-HT mixed Sequence).

Participants were randomly assigned to groups numbered 1 to 4 (i.e., Sequences) based on the ordering in which they appeared in the list of the video call used for the experiment.

Measures

Three sets of dependent variables were collected: source references, treatment selection, and trustworthiness evaluations of the ES. The first two were collected from the essay task. Sources' references were coded as present (1) or absent (0) from the essay. To consider a source present (1) the essay had to include any feature of the source (name, occupation, workplace, publication type) or indirect reference (e.g., the person who gave his/her opinion in the first text), otherwise it was coded as absent (0). Next, for each text in the Presentation Sequence, treatment selection was coded as 1 if they selected the proposed treatment as the best or 0 if they did not. Each text received individual coding, therefore, it was possible for both texts to receive the same coding (i.e., 1, if the essay concluded that both treatments were equally good; or 0, if none was recommended). Thirty percent of the essays were coded independently by the first and last author. Agreement was nearly perfect (97%). Disagreements were resolved by discussion. The first author completed the remaining coding.

Last, ES trustworthiness evaluations were collected via a scale from 0 (not to be trusted) to 10 (extremely trustworthy). Evaluations were collected in two moments, after the presentation of the first text and after the second. Instructions for the first ES evaluation read: "We ask you to rate the trustworthiness of Oscar Prat, a nurse in a pulmonology service, on a scale from 0 (not at all trustworthy) to 10 (extremely trustworthy)."

Table 1 Sample of the experimental texts by sections and position within the HT-HT sequence

Area	Text in First Position	Text in Second Position
Document sources (High-Trust)	**Proceedings of the "V International Meeting of Clinical Pneumonology", compilation of highlighted works.**	**"Clinical Medicine", a biweekly publication for the promotion of research and clinical practice among medical experts.**
Document sources (Low-Trust)	**Blog "They Lie", a publication on hidden medical treatments by experts in conspiracy theories.**	**"The Truth" magazine, a publication of medical advances that the pharmaceutical industry is keeping secret.**
Disease description	Cystic fibrosis is the most frequent genetic and incurable disease in the Caucasian population. It is a complex pathology that affects many body organs although it affects each person differently. Pulmonary difficulties are the most serious and determine the prognosis, since continuous infections deteriorate the lungs and sometimes a transplant becomes necessary.	Cystic fibrosis is an inherited disease that primarily affects the lungs and to a lesser extent the pancreas, liver, and intestine, causing the accumulation of thick, sticky mucus in these areas. It is one of the most common chronic lung diseases in children and young adults and is a potentially life-threatening disorder as patients are vulnerable to lung infections.
Embedded source and treatment description	Oscar Prat, a nurse in a pulmonology service, considers that a good treatment is to encourage the child to practice a sport that requires movement. Physical activity is very important because the child can increase his breathing capacity and improve posture and tolerance to effort. The earlier the activity begins, the better (as early as 4 years old). Physical exercise becomes fundamental because it improves the body's defenses.	Oscar Prat, a nurse in a pulmonology service, explains that adapted diets are a good treatment to cope with cystic fibrosis. Those with this disease need to eat nutritious foods more regularly throughout the day. Children need to eat many more calories and fats. This requires learning about the nutrients in each food. With a good diet, there is no need to take supplements.
Closing	It is estimated that in every group of 40 people, at least one individual carries the cystic fibrosis gene without showing any symptoms, which means they could potentially pass it on to their children. Therefore, it is essential to investigate and raise awareness about cystic fibrosis, its symptoms, and how to treat it.	In our country, it is estimated that 1 in every 7200 births is affected by cystic fibrosis. However, this figure might be significantly higher if we consider undetected cases. Therefore, parents and health professionals are encouraged to stay informed about cystic fibrosis and other rare diseases.

Experimental texts presented only 1 DS. Every designed DS (2 high-trust and 2 low-trust sources) is presented for illustrative purposes. The three last sections (disease description, embedded source and treatment description and closing) composed the two versions of the text, one to the right and one to the left. Combinations of DS and text version were randomly assigned to each participant via random number generation automated with PsychoPy. Texts are translated from their original versions in Spanish

The second evaluation instruction was as follows: "We ask you to rate, again, the trustworthiness of Oscar Prat, a nurse in a pulmonology service, who is the same person as in the first text. Your evaluation can be the same or change from the first one, as you see fit. Below you have a scale from 0 (not at all trustworthy) to 10 (extremely trustworthy) to select your response.

The task was designed in Psychopy2 (Peirce et al., 2019) and hosted in Pavlovia (http://pavlovia.org) to be self-administered in a computer after receiving the instructions. This web platform included the instructions, texts, and response fields. Like a webpage, the mouse was used to navigate the tasks and the keyboard (essay task) or mouse clicks (trustworthiness evaluations) to complete the tasks. Given the sequential nature of the tasks, going back to previous pages was not allowed. After both texts and evaluations, a blank space was provided to write the essay. While completing the essays the texts were available by clicking on one of two buttons labeled "First Text" and "Second Text". After completing the essay, the trustworthiness of the DS (manipulation check) was evaluated via the same 10 points scale of the ES evaluations.

Procedure

The data was collected in synchronous sessions via Google Meets, in groups of 3 to 15 participants. Participants signed the informed consent form as they connected to the meeting.

The first activity was a pre-training regarding the importance of sources during internet reading (up to 25 min; for details see Pre-training). Next, the reading phase began with the following instructions: "Imagine that you started to learn about a new subject in college: Cystic Fibrosis, a rare disease. First, as you may know or not this disease, indicate how much you know about Cystic Fibrosis on a scale from 0 to 10, being 0 *I know nothing* and 10 *I know a lot about the topic* (…). Your teacher asked you to do an assignment for the next class that requires you to read two texts about cystic fibrosis and to write a text explaining which treatment for this disease is the best. To do this assignment you searched the internet and found the following texts. Read them carefully because you will have to work with them later. *Attention: first one text will be presented and then the other, and you will not be able to go back to the first one. This is why it is important that you read them carefully.* Remember that it is important to keep in mind what was discussed prior to this activity (the workshop)."

After finishing reading the first document, the participants evaluated the ES for the first time; the document was not available during this assessment. Then, they read the second document and evaluated the ES for a second time. Before the second assessment, participants were explicitly reminded that the ES was the same as in the first document. They were also told that they may keep or modify their initial evaluation as they saw fit (for detailed instructions, see Measures).

Last, participants were reminded of the essay task: "Now that you have read the texts, write your essay on which of the two treatments you consider to be the best for cystic fibrosis and why. It is very important that you state your arguments to explain why you make that decision. Next, you will access a page to write your essay and you will be able to consult the texts if you need. The essay should be short, about 5–8 lines." Upon completing the essays, they were presented with both DS and evaluated their trustworthiness (manipulation check). The whole activity lasted about 50 minutes.

Statistical analyses

Analyses were performed in Jamovi V.2.5 (The Jamovi Project, 2024) with the addition of the module GAMLj (Gallucci, 2019).

Descriptive analyses included absolute and relative frequencies for the sources' references, treatment selection and mean and standard deviations for the trustworthiness scores.

To test the hypotheses, we fitted mixed models. The manipulation of sequence was decomposed in Sequence Type (HT-HT, LT-LT, HT-LT, LT-HT) and Position within the sequence (first position, second position) for its analysis. This was done to better capture the goal of this research, namely, to examine a potential modification of the trustworthiness as a function of the sequence, but also the position of the document in that sequence.

To evaluate trustworthiness scores of the ES linear mixed models were used. The scores of the trustworthiness evaluations were set as the response and Sequence Type and DS Position within the sequence were added as interactive factors. The model also included random intercepts to account for variation across individuals and items version (see Table 1).

For treatment selection and DS references, mixed logistic models were fitted. Predictors and random effects were the same as for the trustworthiness model. When performing multiple comparisons p values were adjusted via the Holm-Bonferroni method. ES references were evaluated via a chi square test of independence.

Estimated marginal means and confidence intervals (linear mixed models) or odds ratios (OR) and confidence intervals (logistic mixed models) are reported as indicators of the effects' strength and precision. Complete reports of the models can be consulted on the Appendix.

Results

Trustworthiness evaluations (H1)

Trustworthiness evaluation data from five participants (6.49% of the original sample) was not registered in the online database. Therefore, these analyses were performed only on the remaining 72 participants.

Table 2 presents the descriptive analyses of trustworthiness evaluations, both for the ES and the DS (i.e., manipulation check). The inferential analyses of trustworthiness evaluations were conducted via linear mixed models and the estimated means are presented in Fig. 1. After reading the first text, the trustworthiness evaluations of the ES did not vary between sequences, all $p > .294$, with an estimated mean of 4.36, $SE = 0.36$. After the second reading, significant differences were observed between sequences finishing with high-trust DS, HT-HT: $M = 5.34$, $SE = 0.70$, and LT-HT: $M = 6$, $SE = 0.82$, and those with low-trust DS, LT-LT: $M = 2.22$, $SE = 0.70$, and HT-LT: $M = 2.53$, $SE = 0.68$, all $p < .006$.

Finally, ES evaluations did not change between Position within the sequence in the HT-HT and LT-LT sequences, $t(66) = -0.82$, $p = .415$ and $t(66) = 1.38$, $p = .171$, respectively. In contrast, the evaluations changed in the mixed sequences in the HT-LT Sequence Type, ES trustworthiness decreased on average 2.5 points from position 1 ($M = 5.05$, $SE = 0.68$) to 2 ($M = 2.53$, $SE = 0.68$), $t(66) = 4.04$, $p < .001$. In the LT-HT Sequence Type, it increased 2 points from first position ($M = 4.46$, $SE = 0.82$) to second ($M = 6$, $SE = .82$),

Table 2 Means and standard deviation of the trustworthiness evaluations scores for ES and DS as a function of sequence type and position within the sequence

Sequence Type	Position within the sequence	Trustworthiness evaluation (0–10)			
		Embedded source		Document sources	
		M	SD	M	SD
HT-HT	Position 1 (high-trust)	4.85	3.20	6.90	2.43
	Position 2 (high-trust)	5.35	3.33	6.06	2.78
LT-LT	Position 1 (low-trust)	3.11	3.22	2.22	3.04
	Position 2 (low-trust)	2.22	2.88	2.65	2.67
HT-LT	Position 1 (high-trust)	5.05	2.68	7.90	2.34
	Position 2 (low-trust)	2.53	2.52	1.11	1.29
LT-HT	Position 1 (low-trust)	4.50	2.53	2.93	2.70
	Position 2 (high-trust)	6.26	3.15	7.86	2.38

DS trustworthiness is presented only as a manipulation check

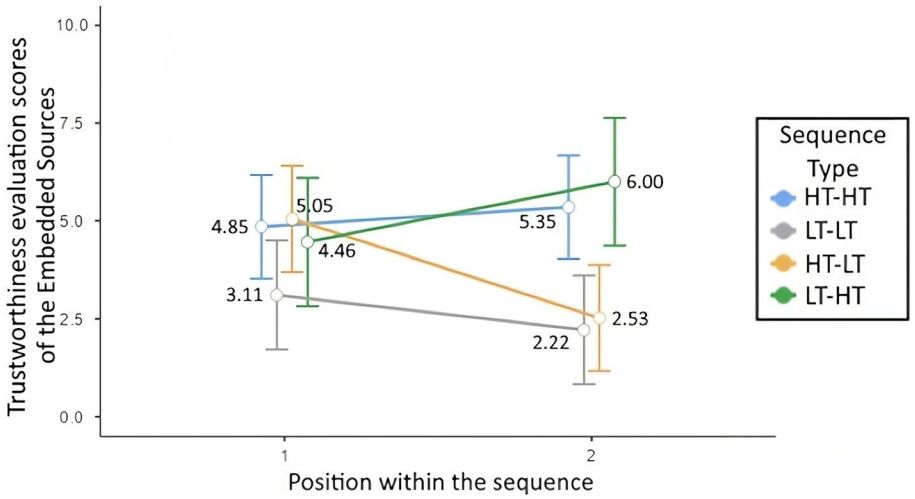

Fig. 1 Estimated trustworthiness scores of the embedded source as a function of Sequence Type and Position within the sequence. Error bars represent the 95% confidence interval of the predicted probabilities of treatment selection

$t(66) = -2.03$, $p = .046$. Lastly, the manipulation check confirmed that the evaluations of the DS corresponded to those expected, $F(1, 148) = 66$, $p < .001$.

Essays productions: Source references (H2) and treatment selection (H3)

One participant did not produce the essay. Therefore, source mentions and treatment selection analyses are conducted on a sample of 76.

We analyzed the effect of Sequence Type and Position within the sequence on the references to DS and treatment selections. To analyze ES mention frequency, only

Sequence Type was considered (the ES in both texts was the same). References to sources and treatment selections can be found in Table 3.

Regarding references to the DS, the model showed a significant interaction between Sequence Type and Position within the sequence, z (152) = 2.62, p = .009. Among the texts in first position the one from HT-LT condition was mentioned more than those of other Sequence Types, all p < .049. Additionally, references to the text in the first and second position of the HT-LT Sequence were also significantly higher in the first one, OR = 9.31, 95% CI [−9.07–27.70], z = 2.22, p = .027. The odds of the references to the DS in the remaining Sequences (i.e., HT-HT, LT-LT, and LT-HT) were similar in the first position, all p > .633, and the odds of every Sequence Type were similar in the second position, all p > .110. Nonetheless, note that the LT-HT Sequence showed a similar pattern to that of the HT-LT. No other significant difference was observed between texts of first and second positions within each Sequence Type, all p > .082. This interaction can be inspected in Fig. 2.

For references to the ES, the effect of Sequence Type was non-significant, $X2(3)$ = 1.45, p > .69. For treatment selection, we found a significant interaction between Sequence Type and Position within the sequence. Whereas the preference for the first or second text treatment was not evident in HT-HT, OR = 0.65, 95% CI [−0.18–1.49], $z(150)$ = −0.65, p = .517, and LT-LT sequences, OR = 0.80, 95% CI [−0.25–1.85], $z(150)$ = −0.33, p = .739, the odds of selecting the treatment provided in the text with high-trust DS were higher than those for the treatment of low-trust DS in HT-LT and LT-HT Sequences, HT-LT: OR = 107.66, 95% CI [−147.97–361.31], $z(150)$ = 3.89,

Table 3 Frequencies and percentages of the total in each sequence for the references to DS, ES, and treatment selections

Sequence Type	Position within the sequence	Treatment selection				DS references		ES references	
		Chooses		Does not choose					
		f	%	*f*	%	*f*	%	*f*	%
HT-HT	Position 1 (high-trust)	9	23.7%	10	26.3%	6	15.8%	5	26.3%
	Position 2 (high-trust)	11	28.9%	8	21.1%	4	10.5%	–	
LT-LT	Position 1 (low-trust)	9	26.5%	11	27.5%	6	15%	5	25%
	Position 2 (low-trust)	12	30%	8	20%	5	12.5%	–	
HT-LT	Position 1 (high-trust)	17	42.5%	3	7.5%	13	35.1%	7	35%
	Position 2 (low-trust)	1	2.5%	19	47.5%	7	18.9%	–	
LT-HT	Position 1 (low-trust)	3	9.4%	14	43.8%	4	11.8%	3	17.6%
	Position 2 (high-trust)	14	37.5%	3	9.4%	8	23.5%	–	

Source mentions and treatment selection analysis were conducted on n = 76 participants due to failure to produce an essay of one participant. "Chooses" and "Does not choose" labels refer to whether the participants selected the treatment from the text in the first or second position. DS and ES references indicate the presence or absence of at least one utterance regarding document or embedded sources, respectively. The ES was the same in both texts and it is counted only once

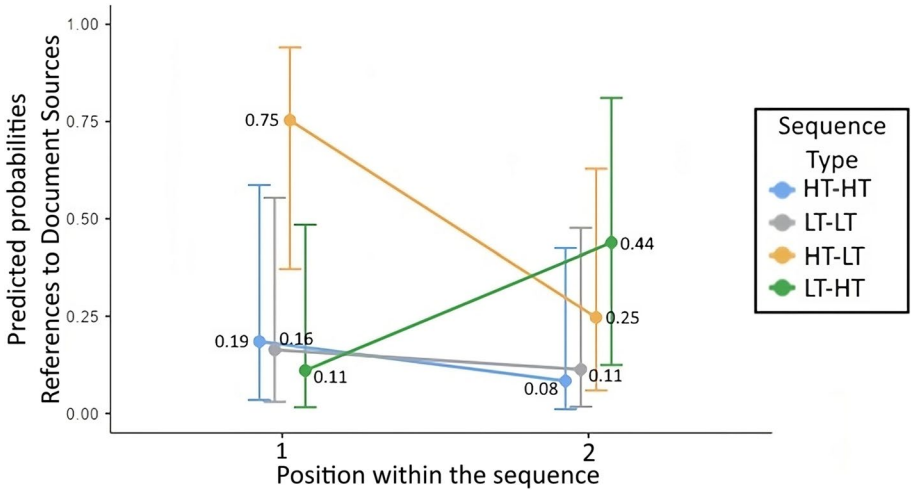

Fig. 2 Estimated probabilities of references to the document source in participants essays as a function of the Sequence Type and the Position of the DS within the Sequence. Error bars represent the 95% confidence interval of the predicted probabilities of references to DS in the essay. Estimated Probabilities of References to the Document Source as a Function of Sequence Type and Position Within the Sequence

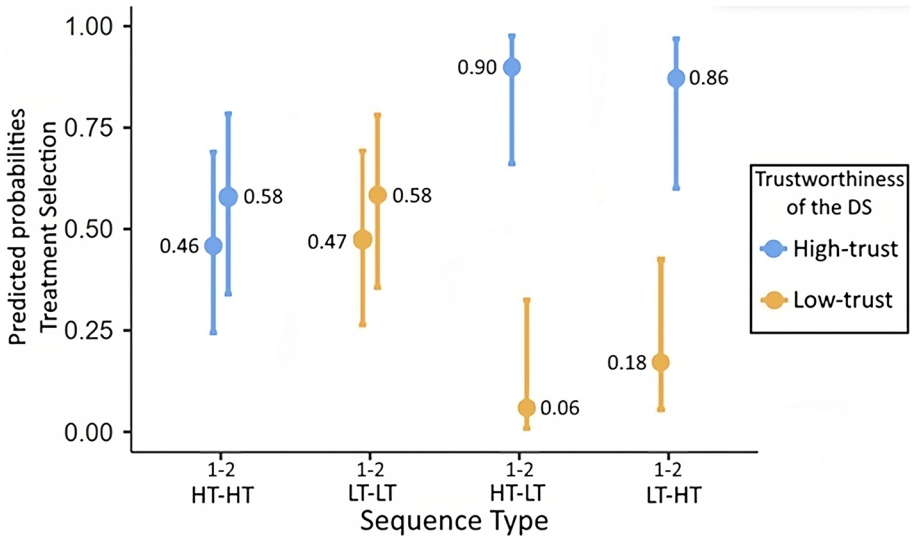

Fig. 3 Estimated probabilities of selecting the treatment in the texts as a function of their Sequence Type and Position within the Sequence. Error bars represent the 95% confidence interval of the predicted probabilities of treatment selection. Numbers 1 and 2 indicate the Position within the sequence

$p < .001$; LT-HT: OR = 0.05, 95% CI [−0.05–0.16], $z(150) = -3.87$, $p = .004$. The estimated probabilities of treatment selection can be seen represented in Fig. 3.

Discussion

This experiment examined the dynamics of source-guided evaluations when reading unfamiliar health recommendations in a multiple-document online scenario. We examined whether the document source (DS) trustworthiness would influence an embedded source (ES) trustworthiness evaluation after reading it in two different documents. Furthermore, we examined the adoption of the information provided by the ES and references to both DS and ES as a measure of source use in a justification essay. Overall, the results highlight the role of contextualization, both of source layers and reading sequence, on purposeful reading.

First, the predictions concerning the influence of DS trustworthiness on ES trustworthiness evaluations were consistent with the data. When DS were similar in trustworthiness, ES evaluations did not change (i.e., low scores for the LT-LT sequence: H1a; high scores for the HT-HT sequence H1b). Conversely, when DS differed in terms of trustworthiness, ES evaluation shifted. That is, the perceived trust in the ES decreased after reading the second text in HT-LT sequences (H1c) and increased after reading it in LT-HT sequences (H1d).

This suggests that the readers used the information available from the DS to weigh the trustworthiness of the ES at each evaluation point (after the first and second document). In a sense, these results align with those previously reported (Londra & Saux, 2023) but also reveal that the linked trustworthiness effect shifts, at least to a certain extent, based on updated contextual DS information. However, it is noteworthy that ES evaluations varied between HT and LT DS only in the second document, but not in the first. This is somewhat surprising as participants received a brief training on source trustworthiness assessment. It would seem as if, in position 1, the participants had assigned a midrange baseline value for all DS, regardless of the manipulation of their descriptions to be either high or low in trustworthiness (see Fig. 1 and Table A1 in the Supplementary Appendix). Of note, participants were blind to the DS trustworthiness manipulation when reading the document in position 1 (due to the between-subjects design) and were only able to note a difference after reading the document in position 2 in mixed sequences. Being able to compare at least two sources may have been a necessary condition to account for what is high and low in this specific task.

Thomm and Bromme (2016) found that readers' memory of sources and their evaluations varied based on the contrast between the characteristics of the sources. When readers were tasked with resolving a conflict between two documents, their credibility assessments of the sources shifted according to how the sources differed in key attributes. For example, an expert and benevolent source, such as a university professor, was judged to be more credible when compared to a less benevolent source, like a researcher in industry. This contrast in benevolence led to higher credibility ratings than when the same professor was compared to sources whose benevolence was not in question. The authors argued that such differences in critical source characteristics can lead to increased sourcing. In a similar venue, Gottschling and Kammerer (2021), found that attributing two conflicting scientific claims to two sources contrasted in trustworthiness increased visual attention to sources, and acceptance and intention of use of the information, as compared to sources

equaled in trustworthiness (either high or low). More recently, Abel et al. (2024) asked a sample of high school students to read and evaluate the trustworthiness of multiple online media sources. The sources were presented either interleaved (i.e., alternating their trustworthiness) or blocked (i.e., without alternation). The interleaved presentation facilitated students' ability to identify characteristics of trustworthiness and increased their trust in and use intention for trustworthy sources.

Like the referenced studies (Abel et al., 2024; Gottschling & Kammerer, 2021; Thomm & Bromme, 2016), our results also show that alternating contrasting sources (mixed sequences in this study) enabled a comparison that may be more difficult in a homogeneous sequence. In addition, our results extend this claim to a linked trustworthiness effect; that is, an indirect influence of the evaluation of contrasting (vs. homogeneous) multiple DS on an ES. In sum, by testing how reading order and sources' repetition impact trustworthiness evaluations, this study provides evidence of the situational and dynamic nature of sourcing activities in multiple documents comprehension. An alternative explanation could be that participants only considered DS trustworthiness when asked to evaluate the ES. That is, they reflected only on one layer of source information. However, ES and DS scores actually differed, as shown when contrasting the DV (ES trustworthiness scores) with the manipulation check (DS trustworthiness scores after completing the task), HT-ES Mdn = 5, HT-DS Mdn = 8, W = 1385, $p < .001$, $r_{pb} = .736$; LT-ES Mdn = 2.5, LT-DS Mdn = 1, W = 299 $p = .005$, $r_{pb} = .470$. Overall, the amplitude between high-trust and low-trust scores was larger for DS than ES. This pattern suggests an interplay between different evaluations rather than a one-layered reflection. Nonetheless, specific research should be conducted to fathom whether and how different source types are distinctively evaluated, for example, by asking participants to justify their trustworthiness evaluations, or including several ES assumed to differ in trustworthiness.

Second, regarding the effect of the manipulation on the written productions, we expected more DS (H2a) and ES (H2b) references in mixed than homogeneous sequences. References to DS and ES did not follow the expected pattern. High-trust DS were mentioned more often in one of the mixed Sequences (HT-LT) but not in the other (LT-HT). Sources are often used to resolve conflict across texts and as an element to argue or justify a decision (e.g., Barzilai et al., 2015; Kammerer et al., 2016; Macedo-Rouet et al., 2019). According to the hypothesis, the same should have been observed for the other mixed Sequence (LT-HT). Although this was not the case, the inspection of the estimated probabilities showed a tendency in this direction (see Fig. 2). With respect to ES references, on the other hand, they were generally low, ranging from 17.6% to 35% across conditions. Since the ES was the same in both documents, this lack of contrast may have blurred the differences between mixed and homogeneous Sequences when composing the essay.

Lastly, we expected that the manipulation of the DS would increase the odds of selecting the treatment of the high trust DS for the essay task, as compared to the low trust DS (H3). In mixed sequences, treatment selection followed the expected pattern. Participants from mixed sequences chose the treatment provided by the high-trust DS as the best more often compared to the low-trust DS. Note that in the homogeneous sequences the selection pattern was not distinguishable from a random one, which is to be expected as the DS were similar in trustworthiness. These results are consistent with research showing that people tend to prefer positions or arguments provided by sources they find reliable (e.g., Gottschling et al., 2019; Kobayashi, 2014; Pérez et al., 2018).

In sum, this work extends knowledge regarding the dynamics in trustworthiness evaluations when reading conflicting texts, specifically when the task implies working with little known health topics. The two research questions underlying this research were,

first, whether readers would be sensitive to source layers and, second, whether this effect would change when reading the same ES in a sequence of multiple DS. The results provide evidence of the joint use of source layers in a sequence of documents, but contingent to the existence of a trustworthiness contrast in that sequence. These conclusions highlight the dynamics of ES evaluations, which vary depending on the reading context (i.e., the DS), and the moment when each document is read, reflecting the complex nature of reader-guided processes.

This study does not come without limitations. First, a common bias in psychological research is that participants usually represent a rather narrow population (i.e., young, educated, middle to upper-social-class individuals; Azar, 2010). The results may not be directly applicable to a more diverse group of readers.

Second, some of the hypothesized effects for source references (H2a) were not statistically significant but followed the expected direction. We cannot rule out that a larger sample size may provide evidence supporting the predicted effect.

Third, this study focused on elements of the reading situation (i.e., task and materials). However, it did not examine the potential role of individual differences (e.g., beliefs, prior knowledge, interest, motivation, perceived relevance), although evidence shows that these factors influence sourcing behavior (Anmarkrud et al., 2022). Future research would be needed to explore how these factors may influence the use of sources organized in layers.

Fourth, there are limitations related to the task and materials used. Considering the importance of health-related internet searches and the associated risks, we chose a specific health topic for our study. Nonetheless, it could be that evaluative efforts on other thematic areas (e.g., politics, leisure activities, economics, education) are approached differently than when reading health information. Additionally, both documents were read in an ordered manner, with no navigation, no going back, and no other available options. Among other, these affordances of digital reading may partially shape how a document is evaluated. It may even be that if more documents were available, seemingly low-trust sources would be outright discarded before a proper evaluation takes place. Furthermore, we cannot discard whether wider availability of documents or the possibility of rereading the documents may change the evaluations or the essays.

Last, regarding the task, the reading situation was highly structured. Participants received a pre-training to help them evaluate the documents, were prompted in the instructions to use source information, and were reminded that the ES was the same when assessing the second document. Our results may reflect reading situations where people thoughtfully try to comprehend documents instead of reading situations with a lower threshold of epistemic vigilance.

In an applied level, our results can relate to the design of interventions aimed at promoting critical or analytical reading. On a broad scope, training on metacognitive strategies promotes the formation of more balanced representations, diminishing belief-consistency biases (Abendroth & Richter, 2021; Maier & Richter, 2014), increased factual knowledge and use of sources when reading about an unfamiliar medical topic (Stadtler & Bromme, 2004), and improved task engagement and argumentation quality in post reading essays (Tarchi, 2024). Our study may line more directly with interventions focused on the attentive monitoring of sources' features to determine their trustworthiness based on the reading task (Martínez et al., 2024; Pérez et al., 2018). For example, Macedo-Rouet et al. (2024) showed that modelling the analytic step-by-step process of purposeful reading (e.g., reflecting on the information required by the specific reading task and monitoring available cues of texts' quality and reliability) improved search and evaluation skills online.

Our research highlights the impact of reading order and the contrast between different sources. Future intervention studies could benefit from explicitly encouraging readers to monitor how sources with significantly differing trustworthiness may influence their perception of reliability compared to when each source is read in isolation. While focusing on source features is an important first step in evaluating trustworthiness, understanding how variations in trust and reading order affects assessments could lead to deeper and more nuanced evaluations.

Conclusion

Evaluating information found on the internet is a crucial aspect of proficient digital reading. Therefore, interventions that prompt source evaluations have been proposed as effective methods for supporting complex reading strategies (Brante & Strømsø, 2018). Our findings emphasize the importance of recognizing factors such as contrast, reading order, and the potential impact of sources presented in a layered manner when reading to make informed decisions and their dynamic nature.

Supplementary Information The online version contains supplementary material available at https://doi.org/10.1007/s11409-025-09427-z.

Author contributions Franco Londra and Gaston Saux contributed to the study conception and design. Material preparation and data collection was performed by Franco Londra and Magalí Martínez. Data analyses were performed by Franco Londra and Gaston Saux. The first draft of the manuscript was written by Franco Londra. Magalí Martínez and Gaston Saux commented on previous versions of the manuscript and provided comments on results interpretation and discussion. All authors read and approved the final manuscript.

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Data availability Raw data and scripts are available upon sensible request to the corresponding author.

Disclosures

Conflict of interest The present research was conducted under a doctoral fellowship co-funded by the National Scientific and Technical Research Council (CONICET) and the Argentine Catholic University (UCA). The authors declare that they have no conflict of interest.

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