Brain and Cognition 186 (2025) 106290

Contents lists available at ScienceDirect

Brain and Cognition

journal homepage: www.elsevier.com/locate/b&c

Providing an alternative explanation improves misinformation rejection and alters event-related potentials during veracity judgements

Sean Guo[a], Danni Chen[a], Xiaoqing Hu[a,b,c,*]

[a] Department of Psychology, The University of Hong Kong, Hong Kong SAR, China
[b] The State Key Laboratory of Brian and Cognitive Sciences, The University of Hong Kong, Hong Kong SAR, China
[c] HKU-Shenzhen Institute of Research and Innovation, Shenzhen, China

ARTICLE INFO

Keywords:
Misinformation
EEG
ERP
Continued Influence Effect
Memory

ABSTRACT

The continued influence effect of misinformation (CIE) occurs when misinformation affects memory and decision making even after correction. Here, we examined the neurocognitive processes underlying the correction and subsequent veracity judgements of misinformation. Employing electroencephalography (EEG), we examined event-related potentials (ERPs): the P300 during encoding of corrections, and the P300 and FN400 during subsequent veracity judgement. We compared ERPs between three conditions: misinformation that was retracted (retraction only), misinformation that was retracted with a correct alternative cause provided (retraction + alternative), and true information that was later confirmed (confirmation). Results showed that alternatives reduced the CIE significantly. During veracity judgements, the retraction + alternative condition exhibited a higher P300 than the retraction only condition, suggesting enriched recollection processes when re-encountering misinformation if an alternative explanation existed. In contrast, both retraction only and retraction + alternative conditions elicited a less negative FN400 compared to the confirmation condition, suggesting higher conceptual processing fluency of misinformation. Moreover, we found that greater levels of P300 when encoding retraction and alternative causes in the retraction + alternative condition were associated with improved veracity judgement accuracy. Together, these findings suggested that when providing an alternative cause in correcting misinformation, both recollection and encoding processes contributed to reduced CIE.

1. Introduction

Identifying and correcting misinformation is crucial for making rational decisions using valid information. However, even when misinformation is explicitly retracted, it sometimes continues to influence our attitudes, judgements, and decision making, a phenomenon known as the continued influence effect (CIE, Wilkes & Leatherbarrow, 1988). The CIE is typically induced by first providing a crucial piece of misinformation (e.g., a causal explanation for an event), then subsequently retracting it. The outdated misinformation often continues to exert influences on decision making despite intact memory for the correction (Ecker et al., 2022; Wilkes & Leatherbarrow, 1988).

Empirical findings have consistently shown that a retraction compounded with an alternative explanation can reduce the CIE more than a mere retraction, presumably filling the gap in understanding caused by a retraction (Chan et al., 2017; Ecker et al., 2022; Lewandowsky et al., 2012). However, the neurocognitive mechanisms underlying the effectiveness of an alternative explanation remains unclear. Extant literature proposes two theoretical models to explain the CIE, and the role of correction in its reduction. The integration model (also known as the mental model) posits that the CIE is mediated by encoding processes, such that successful encoding and integration of retractions with misinformation is necessary to reduce the CIE (Blanc et al., 2008; Ecker et al., 2017; Kendeou et al., 2014). According to this model, a retraction by itself may lead to gaps in understanding, and an alternative explanation can fill this gap during encoding. The alternative explanation would result in a coherent model of the event and subsequently reduce the CIE (Ecker et al., 2022). On the other hand, the selective retrieval model (also known as concurrent storage, retrieval failure, or activation model) posits that biased memory retrieval leads to the CIE (Ayers & Reder, 1998). If misinformation is highly familiar, it can be automatically reactivated by retrieval cues and perceived fluently, giving rise to the CIE when strategic monitoring fails. This strategic monitoring often implicates contextual recollection of misinformation and its corrections

* Corresponding author at: Department of Psychology, The University of Hong Kong, Pokfulam, Hong Kong SAR, China.
E-mail addresses: seanguo@connect.hku.hk (S. Guo), dnchen@connect.hku.hk (D. Chen), xiaoqinghu@hku.hk (X. Hu).

https://doi.org/10.1016/j.bandc.2025.106290
Received 28 October 2024; Received in revised form 1 March 2025; Accepted 6 March 2025
Available online 13 March 2025

during veracity judgements (Ayers & Reder, 1998; Butterfuss & Kendeou, 2019; Schwarz et al., 2007). According to this model, providing an alternative explanation may decrease the activation of misinformation and improve the efficacy of strategic monitoring processes, thus reducing the CIE. While the two models have been previously represented as competing explanations, they also complement each other, because the CIE can arise from both encoding and retrieval failures (Ecker et al., 2022). The present study aims to use electroencephalography (EEG) to investigate both encoding and retrieval processes in the CIE paradigm (retraction, correction, and veracity judgment) to examine how and why alternative explanations can better reduce the CIE.

Although previous neuroimaging studies using functional magnetic resonance imaging (fMRI) and EEG have examined the CIE (Brydges et al., 2020; Gordon et al., 2017, 2019; Jin et al., 2022; Lee et al., 2022), none have explored the mechanisms underlying provision of an alternative explanation. While Gordon et al. (2019) examined differences between confirmations and alternatives, they were unable to explore differences between providing an alternative and a retraction without an alternative. Furthermore, findings regarding the neurocognitive mechanisms of CIE have been mixed. fMRI studies have found evidence for both the integration model and selective retrieval model (Gordon et al., 2017, 2019; Jin et al., 2022), while EEG studies have only provided support for the selective retrieval model (Brydges et al., 2020; Lee et al., 2022).

Discrepancies could be due to different task demands, as some studies required participants to simply comprehend the material (Brydges et al., 2020; Gordon et al., 2017; Jin et al., 2022), while others instructed participants to actively verify incoming information (Gordon et al., 2019). Additionally, some studies do not explicitly address correction credibility to participants (Brydges et al., 2020; Gordon et al., 2017; Jin et al., 2022), which may have led to varying levels of belief and conflict detection in participants (Ecker & Antonio, 2021). In the present study, we ensured that participants would pay attention and actively process misinformation corrections, by instructing them that their memory for the corrections would be tested later. Moreover, to minimize individual differences in beliefs on correction reliability, participants were explicitly told that information presented later would always be more accurate.

To elucidate the effect of alternative explanations during both encoding and retrieval of misinformation, we designed a new EEG-based CIE paradigm with a few notable changes from previously established CIE studies (Johnson & Seifert, 1994; Wilkes & Leatherbarrow, 1988). Firstly, our study included three conditions: 1) misinformation that was merely retracted (i.e., retraction only), 2) retracted but with an alternative (i.e., retraction + alternative), or 3) correct information that was confirmed (i.e., confirmation). Secondly, our paradigm uses single word stimuli instead of sentences to present key information such as causes of an event, retractions, and alternative causes – this ensures that mental processes related to encoding retractions and alternatives are precisely time-locked to the event-of-interest. Thirdly, many previous studies tested the CIE immediately after encoding each event, which may tax short-term memory (Brydges et al., 2020; Gordon et al., 2017, 2019; Jin et al., 2022). However, oftentimes when we re-encounter misinformation, we rely on long-term memory to determine its veracity (Swire-Thompson et al., 2023). Our study separated encoding and testing trials with longer delays (20–30 min) than previous studies to better mimic retrieval of misinformation and corrective details outside the laboratory.

Aided by the EEG's millisecond temporal resolution in unraveling on-going information processes, we aim to investigate how encountering misinformation, retractions, and alternatives may modulate event-related potential (ERP) activity, especially those highly related to encoding and retrieval processes (Friedman & Johnson, 2000; Mecklinger, 2010; Mecklinger et al., 2007; Rugg & Curran, 2007). Specifically, during the encoding task, we planned to focus on the encoding P300 while presenting misinformation, its corrections, and its alternatives. The encoding P300 indexes depth of memory encoding, context updating and attentional allocation (Brydges & Barceló, 2018; Donchin, 1981; Polich, 2007, cf. Rac-Lubashevsky & Kessler, 2019). During the subsequent veracity judgment task, we planned to investigate similar components to a previous EEG-CIE study (Brydges et al., 2020), namely the retrieval P300 and the FN400 time-locked to misinformation presentation. Evidence suggests that the retrieval P300 is linked to episodic recollection processes, with higher P300 amplitudes indicating richer contextual retrieval of an early encoding episode (Curran, 2000; Finnigan et al., 2002; Yang et al., 2019). On the other hand, the retrieval FN400 has been linked to conceptual processing fluency, with a smaller amplitude (i.e. less negative) tracking higher fluency even when conscious recollection is absent (Mecklinger & Bader, 2020, Nie et al., 2021; Strozak, Abedzadeh, & Curran, 2016; Strozak, Bird, et al., 2016).

The integration model posits that updating an event model with retractions recruits integration processes and that alternative explanations reduce the CIE by filling in gaps in understanding (Ecker et al., 2022; Kendeou et al., 2014). Integration between a correction and the original misinformation likely recruits memory encoding processes, reflected in enhanced P300s. If this is the case, we would expect greater encoding P300s to correlate with more accurate veracity judgments in both retraction only and retraction + alternative conditions. The selective retrieval model hypothesizes that the CIE arises due to failed strategic monitoring processing and increased misinformation fluency during memory retrieval (Ayers & Reder, 1998; Ecker et al., 2022; Schwarz et al., 2007). Accordingly, during the veracity judgment task, we would expect greater recollection (more positive P300) and less fluency (more negative FN400) to misinformation that has an alternative explanation compared to misinformation without an alternative during the veracity judgement stage.

2. Methods and materials

2.1. Participants

We recruited 59 students from the University of Hong Kong (39 female; M = 21.0 years, SD = 3.5). Participants reported normal or corrected-to-normal vision, no colorblindness, no chronic medical conditions, no history of severe mental illness and no neurological disorders. They were pre-screened on English fluency (must be a native speaker and/or received education primarily in English starting from high school). Participants either received monetary compensation (at approximately 10 USD/hour) or course credit for participation. Participants were recruited through mass emails as well as from participant pools. Participants were excluded due to errors in data collection ($n = 1$) or due to low scores on the word familiarization task ($n = 2$, described below). Participants were further excluded if they had fewer than 20 clean encoding ($n = 15$) or veracity judgement ($n = 8$) EEG epochs for EEG analysis (see below). We also examined potential outliers in veracity judgement performance using the 3 median average deviations criteria, but no outliers were identified. For results, we reported behavioral analyses from 56 participants, encoding EEG analyses from 41 participants, and veracity judgment EEG analyses from 48 participants. This research was approved by the Human Research Ethics Committee of the University of Hong Kong (EA210341).

2.2. Stimuli

Because of our new experimental paradigm, we conducted a pilot study to choose materials before data collection. Eleven student volunteers from the University of Hong Kong completed an image and word rating task. Volunteers were shown individual trials, consisting of an image, a short descriptive phrase related to the image (henceforth referred to as the ‘event’, e.g. “building collapse”), and two plausible cause words of the event. Volunteers viewed 150 trials in total, and we aimed to have 120 trials for the final experiment. For each trial, participants rated their emotional reaction and arousal to the images, the degree of relatedness of each image to the event, and their emotional reaction and arousal to the two cause words. Finally, they completed likelihood ratings – indicating which of the two causes was more likely to cause the event. All ratings were completed on a scale from 1 to 3. Among the 150 trials tested, one trial (n = 1) was removed due to feedback from volunteers that it was too similar to another trial. We aimed to minimize situations where one cause may be more easily associated with an event compared to another cause. Therefore, we removed trials with an average rating greater than 2.5 or less than 1.5 in the relatedness and likelihood ratings (n = 22). Then, to reduce potential differences due to emotionality, we removed trials with the highest and lowest image emotion ratings (2.54 and 1.36, n = 2), and trials with the highest and lowest emotion ratings for the first cause word (2.77 and 1.22, n = 2) and second cause word (2.76 and 1.22, n = 2). Finally, to ensure the likelihood of trials were perceived consistently across participants, we removed the trial with the highest likelihood rating standard deviation (0.71, n = 1). In the final study, 120 stimulus sets (each containing an image, event and two causes) remained for the CIE task (for ratings of the remaining stimuli, see supplement A).

2.3. Experimental Procedure

The experiment was administered through PsychoPy version 2020.2.10 (Peirce et al., 2019). Participants completed two tasks in order: a word familiarization task, followed by an EEG-based Continued Influence Effect (CIE) task. In the word familiarization task, participants read words that would be used in the CIE task. In the EEG-based CIE task, participants completed encoding and veracity judgment tasks. During encoding, participants memorized a set of news stories and were then given 'fact checks' about each story (Fig. 1A). Afterward, participants completed a 3-back task (around five minutes) as a distractor. During

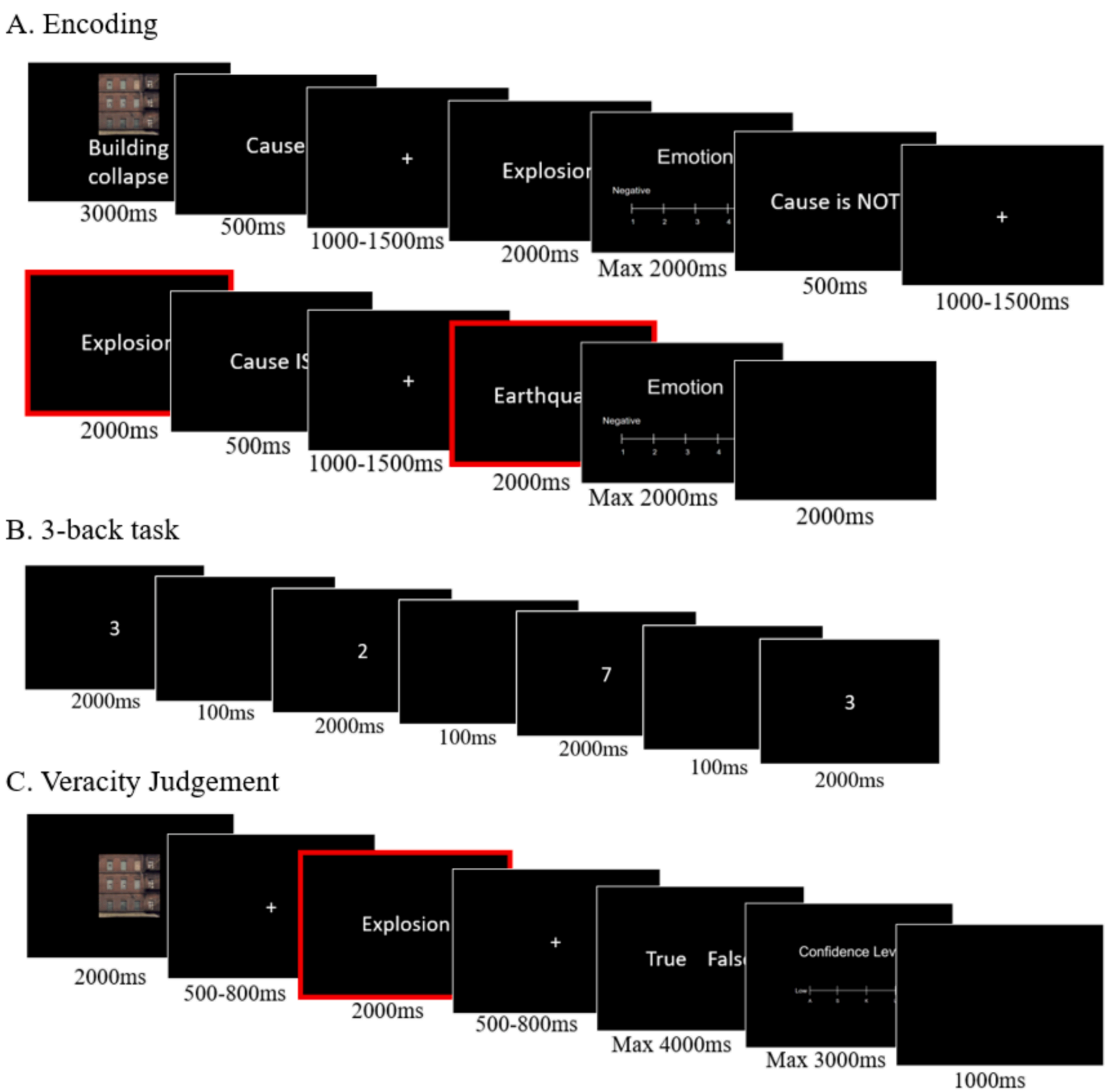

Fig. 1. Example procedural flow in the retraction + alternative condition. **A.** Each trial in the encoding block began with an image and a short descriptive phrase (i.e. the event). Then, an initial cause was presented, followed by an emotion rating stage. Afterwards, participants received information about what the cause is not, and finally what the correct cause is. The task ended with a second emotion rating stage identical to the first. Red outlines denote epochs where stimulus-locked P300 data are analyzed. **B.** Between encoding and veracity judgement tasks, participants completed a 3-back task, where they identified if the current number shown was the same as a number presented three trials ago. **C.** Each veracity judgement trial began with an image from the previous encoding task without the event, followed by a cause word. Participants discerned whether the cause was true or false, and rated their confidence in their answer. Red outlines denote epochs where stimulus-locked P300 and FN400 data are analyzed.

subsequent veracity judgement, they had to discern if the cause for a given news event was true or false (Fig. 1B). The CIE task was split into two blocks, each consisting of 60 encoding trials, a five-minute 3-back task, and 120 veracity judgement trials. Each block used different stimuli to reduce participants' memory load and have a more varied task set to maintain concentration throughout the experiment.

Word Familiarization task. In the task, participants were shown one word (that would later appear as causes for events) at a time on a computer screen (max 3 s) and had to indicate whether they knew the word or not using either the 'a' or the 'l' key. Key presses were counterbalanced between participants, and the current word was replaced by the next word when a key was pressed. This familiarization task was set up to attenuate novelty-related EEG responses and ensure that participants understood the meaning of the words presented in the CIE task. Two participants were excluded from the experiment as they recognized less than 80 % of the words. For remaining participants, they recognized 96.8 % of the words on average, with a standard deviation of 3.7 %. For each participant, trials containing unrecognized words were excluded from later behavioral and EEG analyses.

EEG-based CIE task. The task consisted of two encoding-veracity judgement blocks. In each block, participants first encoded 60 images and events divided into four conditions (Fig. 1A). Participants then completed a five-minute 3-back working memory distractor task, during which participants determined if the current number on the screen was the same or different than the number presented three trials ago. Participants received accuracy feedback on their performance. Finally, they completed a veracity judgment task, in which they judged whether the causes of the events were true or false (Fig. 1B). Participants were given practice trials for both encoding and veracity judgement prior to the CIE task. Stimuli order was randomized in each block and between participants.

2.4. Encoding

In each of the two encoding tasks, participants learnt 60 events and their causes. During each encoding trial, participants first viewed an image in the center of the screen with a short descriptive phrase (i.e. the event) below (3 s). Afterward, the word "CAUSE" appeared on screen (0.5 s), followed by a fixation cross. Then, the initial cause of the event was presented on the screen for 2 s. Following this, participants were given a maximum of 2 s to rate their emotional reaction to the situation (image, event and cause together) using the 1 (most negative emotion) to 5 (most positive emotion) keys. Then in the update stage, they saw the cue "Cause is NOT" (0.5 s) followed by a fixation cross, signifying that the next word (presented for 2 s) that would appear is not the actual cause of the event. Afterwards in the final cause stage, they saw the cue "Cause IS" (0.5 s) followed by a fixation cross, signifying that the next word (presented for 2 s) that would appear is the actual cause of the event. Note that cause words in each condition were presented for 2 s for reading and comprehension. Finally, participants rated their emotional reaction on the same 1–5 scale to the situation based on the updated information (2 s). The inter-trial interval (ITI) was set to be 2 s. Fixation duration varied randomly between 1 s to 1.5 s. Each encoding task contained 60 trials, and participants took a self-paced break after every 15 trials.

Depending on the update stage ("Cause is NOT") and the final cause ("Cause IS"), there were four different within-subject conditions. Table 1 shows an example encoding and veracity judgement trial, with each column representing a different condition. Images or causal words that do not differ between conditions span multiple columns.

Trials were randomly distributed evenly among the four conditions so that participants' expectations were controlled – they were unable to predict whether a retraction or a non-retraction, or a retraction-alternative trial would be presented until they read the last word in a trial. Note that the alternative-only condition was only included so that participants would not immediately assume a subsequent confirmation after reading a non-retraction, thus data from the final cause and veracity judgement in the alternative-only condition were not used in either ERP or behavioral analysis. However, as the update stage was identical in confirmation and alternative-only conditions, ERP data in the alternative only condition was merged with the confirmation condition for analysis.

Table 1
Example stimuli presented to participants during encoding and veracity judgement tasks in each of the four experimental conditions.

Condition	Retraction Only	Retraction + Alternative	Confirmation	Alternative Only[3]
Example encoding trial				
Image + Event	 Building Collapse			
Initial Cause	Explosion			
Update (Cause is **NOT**…)	Explosion (*Retraction*)		Earthquake (*Non-retraction*)	
Final cause (Cause **IS** …)	Unknown[1] (*No alternative*)	Earthquake (*Alternative*)	Explosion (*No alternative*)	Structure (*Alternative*)
Example veracity judgement trial				
Image				
Cause 1	Explosion[2]			Explosion[2]
Cause 2	Earthquake[2]			Structure[2]

Note. [1]The word "Unknown" is presented as the final cause in every trial in the retraction only condition. [2]Participants saw each of these cues on different trials in the veracity judgement task in a randomized order. [3]The Alternative Only condition was used to control participants' expectations such that a confirmation did not always follow a non-retraction. Thus, data from this condition was not examined.

2.5. Veracity Judgement

The veracity judgement task in each of the two blocks contained 120 trials, comprising of two causes tested for each of the 60 events from the earlier encoding task in the same block. Each veracity judgement trial started with the event image as a cue (2 s), during which participants were instructed to recall the event and the associated correct cause. Unlike the encoding phase, this image was not accompanied by an event. After a fixation cross (0.5–0.8 s), a cause word appeared on the screen (2 s). Each event was tested twice (once in the first 60 trials, once in the second 60 trials), each time with a different cause. In the retraction only condition, participants were tested on the original misinformation and a 'new' word that had only appeared during the initial familiarization task and not in any subsequent tasks. In the three other conditions, participants were tested on one true and one false cause from the encoding task (Table 1). After another fixation cross (0.5–0.8 s), participants were given up to 4 s to respond true or false using the 'a' and 'l' keys on the keyboard, counterbalanced between participants. After this, participants were given up to 3 s to rate the confidence of their previous answer from low to high using the 'a', 's', 'k', 'l' keys. A blank screen was shown for 1 s before the next trial. No feedback was given during this task.

To equalize the temporal gap between encoding and veracity judgement for all stimuli, each third of the encoding trials was shuffled and presented in the corresponding third of veracity judgement trials. For example, if an event appeared in the first 20 trials of encoding, veracity judgement for that event would also appear in the first 20 trials. Therefore, the time interval between the encoding and retrieval of each stimulus was around 20–30 min.

2.6. EEG Acquisition

Continuous EEGs were recorded with a 64-channel Waveguard cap, connected to an EEGO amplifier (10/20 system; ANT Neuro, Enschede, Netherlands). The online sampling rate was 500 Hz, with the AFz electrode as the ground and the CPz electrode as the online reference during recording. To record eyeblink activity, a horizontal electrooculogram (EOG) was placed 1.5 cm beside the left canthus. The impedance of all electrodes was kept below 20 kΩ during recording.

2.7. EEG Preprocessing

EEG data were processed with MATLAB 2021b, utilizing EEGLAB 2022.0 and ERPLAB 9.00 (Delorme & Makeig, 2004; Lopez-Calderon & Luck, 2014). The EOG, M1 and M2 electrodes were removed from the EEG data before analysis. The data were downsampled to 250 Hz and bandpass filtered between 0.05 and 30 Hz using zero-phase FIR filter implemented in EEGLAB, and a notch filter at 50 Hz was applied to remove line noise using the cleanline function from EEGLAB (Delorme & Makeig, 2004). Bad channels were detected visually, removed, and interpolated before re-referencing to a common average. Interpolated channels were subsequently removed from the data after re-referencing. Continuous EEG were segmented into [-1000, 3000 ms] epochs, relative to the onset of stimuli-of-interest. Epochs containing large movement-related artifacts were rejected manually by visual inspection. To improve Independent Component Analysis (ICA) performance, a 1 Hz high pass filter was passed prior to ICA. After ICA, components corresponding to eye movement and blink artefacts were first identified visually with the ICLabel toolbox (Pion-Tonachini et al., 2019) then corrected. After interpolation of removed channels, automatic artifact rejection was performed on channels in regions of interest (ROI) between −200 ms and 1000 ms. Any epoch containing amplitudes over ± 75 μV was rejected, and epochs containing peak-to-peak differences of over 75 μV in a sliding window length of 200 ms with a step size of 100 ms were rejected. Final trial numbers for each condition are reported below.

In the update stage, the retraction only and retraction + alternative conditions were merged into a single retraction condition ($M = 51.83$ trials, $SD = 5.28$), and the confirmation and alternative only conditions were merged into a single non-retraction condition ($M = 51.29$ trials, $SD = 5.50$). The final cause stage consisted of the following conditions: retraction only ($M = 26.07$ trials, $SD = 2.78$), retraction + alternative ($M = 26.98$ trials, $SD = 2.61$), and confirmation ($M = 26.10$ trials, $SD = 2.71$). The veracity judgement epoch consisted of the following conditions: retraction only ($M = 27.04$ trials, $SD = 2.56$), retraction + alternative ($M = 26.71$ trials, $SD = 2.60$), and confirmation ($M = 26.48$ trials, $SD = 2.68$).

2.8. ERP Quantifications

A left parietal ROI (P1, P3, P5, PO3) and frontal ROI (Fz, F1, F2, F3, F4) were defined based on previous memory and misinformation studies (Brydges et al., 2020; Kiat & Belli, 2017; Volz et al., 2019). Both correct and incorrect trials were included in ERP analyses. For the encoding task, 15 participants with fewer than 20 trials in any condition of interest were excluded. For the veracity judgement task, 8 participants with fewer than 20 trials in any condition of interest were excluded. Before creating ERPs, epochs were further segmented into [-200, 1000 ms] epochs, with the [-200 to 0 ms] pre-stimulus amplitude used for baseline correction.

Exploratory ERP analyses examining only correct trials revealed the same pattern of results. However, note that participants with fewer than 20 trials in conditions of interest were included in this analysis. For full results, please see supplement B.

Encoding and retrieval P300 windows were defined from 300−1000 ms, and adaptive means were obtained in this window. FN400 adaptive means were obtained from a 300–500 ms window. Time windows were informed by visual inspection of peaks in the grand average waveforms. Adaptive means were calculated as the mean amplitude spanning 50 ms before and after the peak value within a time window for the P300, and 25 ms before and after the peak for the FN400. Adaptive means allow for greater flexibility in capturing different peak latencies in an unbiased manner (Nielsen & Gonzalez, 2020).

3. Results

Given our primary interests in the CIE, we first present behavioral and EEG results from the veracity judgment task.[1] All standard errors of the mean (SE) have been corrected for within-subjects comparisons (Morey, 2008).

3.1. Veracity Judgement Behavior

Because both true causes (in the confirmation and retraction + alternative conditions) and misinformation (in the retraction only and retraction + alternative condition) were presented during the veracity judgement task, we conducted separate comparisons for veracity judgements to true information and misinformation. We examined hit rates ('true' responses to true causes in the retraction + alternative and confirmation conditions), and correct rejection rates ('false' responses to misinformation in the retraction only and retraction + alternative conditions).

Paired sample t-tests showed that hit rate in the retraction + alternative condition ($M = 86.1$ %, $SE = 1.18$ %) was significantly higher than in the confirmation condition ($M = 82.0$ %, $SE = 1.18$ %), $t(55) = 2.46$, $p = 0.017$, $d = 0.33$ (Fig. 2A). The retraction + alternative condition ($M = 80.5$ %, $SE = 1.18$ %) showed a significantly higher correct rejection rate than the retraction only condition ($M = 67.0$ %, $SE = 1.18$ %), $t(55) = 8.09$, $p < 0.001$, $d = 1.08$ (Fig. 2B).

Paired sample t-tests showed that response time (RT) for hits in the retraction + alternative condition ($M = 571$ ms, $SE = 11.9$ ms) was significantly faster than in the confirmation condition ($M = 618$ ms, $SE = 11.9$ ms), $t(55) = 2.81$, $p = 0.007$, $d = 0.38$ (Fig. 2C). For correct rejection of misinformation, responses in the retraction + alternative condition ($M = 643$ ms, $SE = 14.9$ ms) were significantly faster than the retraction only condition ($M = 758$, $SE = 14.9$ ms), $t(55) = 5.47$, $p < 0.001$, $d = 0.73$ (Fig. 2D).

In addition, we computed sensitivity (d': Z(hit) – Z(false alarm)) values for the retraction + alternative and confirmation conditions. Sensitivity could not be obtained in the retraction only condition, as hits were not possible due to the absence of a correct cause in that condition. Paired sample t-tests showed that sensitivity in the retraction + alternative condition ($M = 2.27$, $SE = 0.11$) was significantly greater than in the confirmation condition ($M = 1.88$, $SE = 0.11$), $t(55) = 2.53$, $p = 0.014$, $d = 0.34$.

These accuracy and RT results provided consistent evidence that providing both a retraction and an alternative together was more effective than providing only a retraction in reducing the CIE, as evidenced by higher accuracies in identifying true causes and rejecting false causes, and by faster RTs in these judgments. We next examined the

[1] For confidence and emotion rating analyses, please refer to Supplement C.

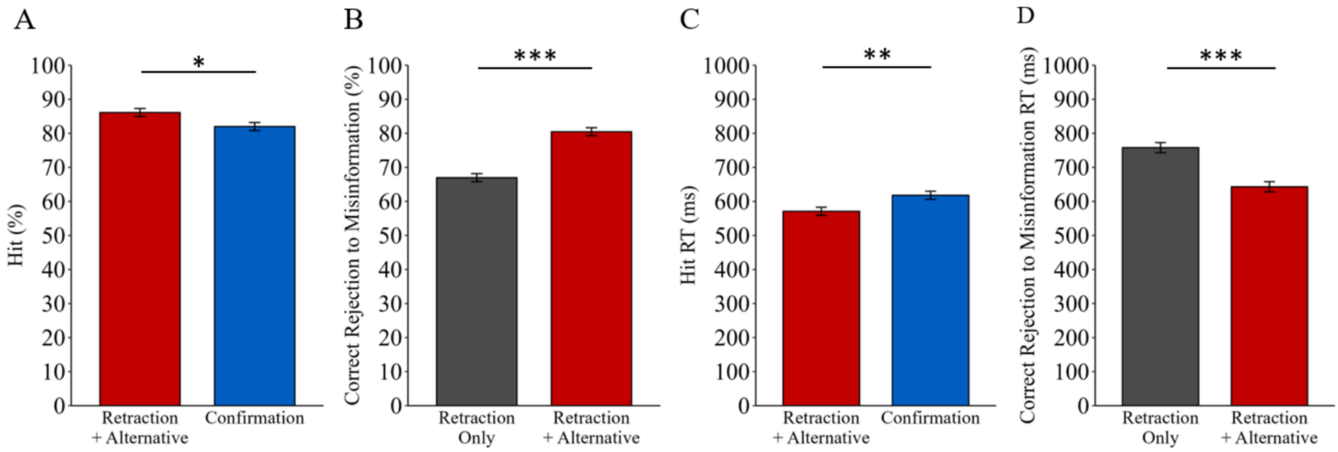

Fig. 2. **A.** Hit rates of retraction + alternative and confirmation conditions. **B.** Misinformation correct rejection rates of retraction only and retraction + alternative conditions. **C.** Response time (RT) for hits in the retraction + alternative and confirmation conditions. **D.** RT for correct rejection to misinformation in the retraction only and retraction + alternative conditions. Error bars represent standard error of the mean. *: $p < 0.05$. **: $p < 0.01$. ***: $p < 0.001$.

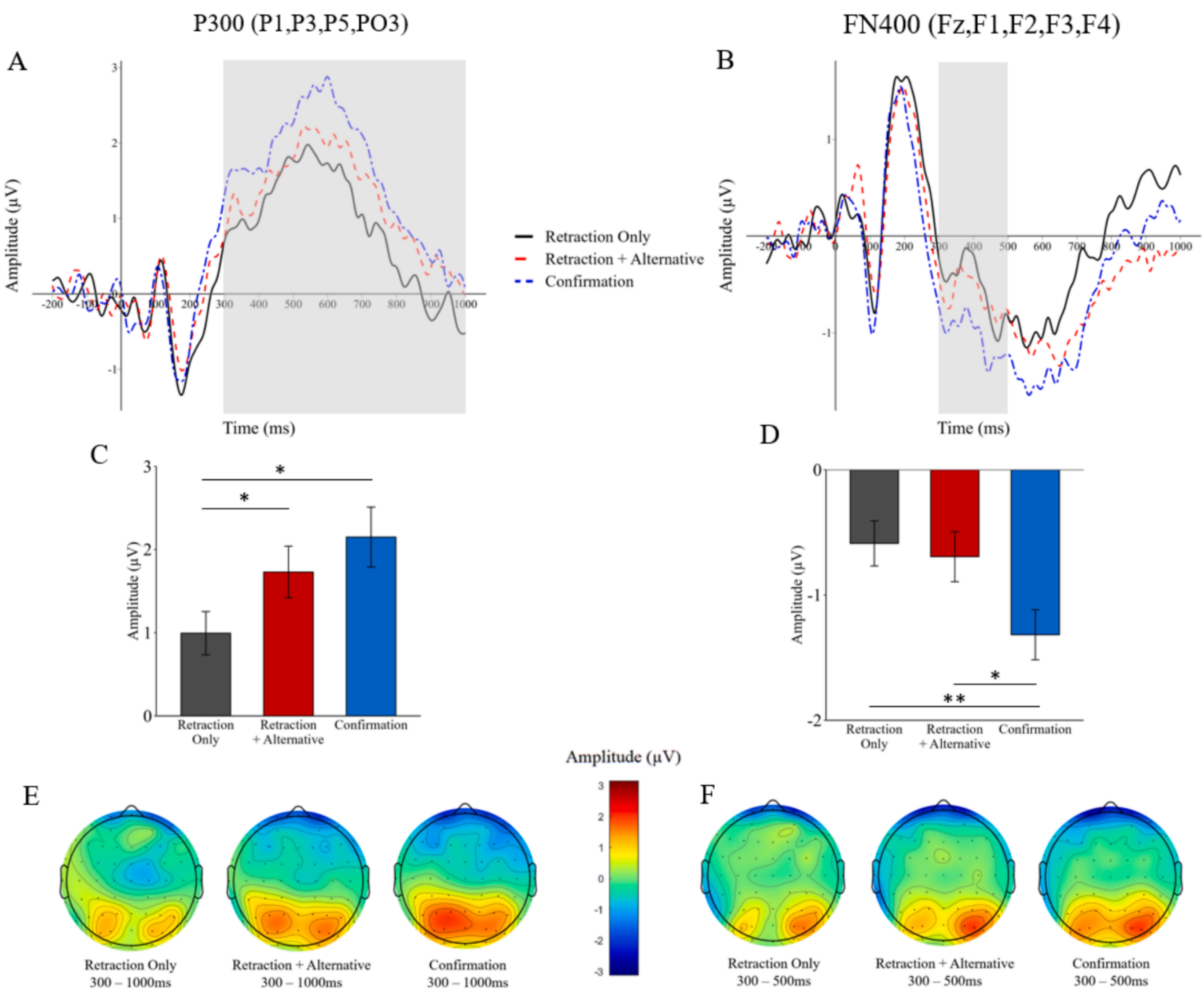

Fig. 3. Grand average ERP waveforms showing activity in **A.** the left parietal region and **B.** frontal region while participants viewed misinformation (retraction only and retraction + alternative conditions) or correct information (confirmation condition) during veracity judgements. Adaptive mean amplitudes for **C.** the P300 and **D.** FN400 components. Error bars denote standard error. *: $p < 0.05$. **: $p < 0.01$. Scalp distributions between **E)** 300 and 1000 ms, and **F)** 300 and 500 ms.

underlying neurocognitive processes.

3.2. Veracity Judgement EEG

In the veracity judgement task, we examined the FN400 and the P300 in the following three conditions: viewing misinformation (i.e. the original incorrect cause) in the retraction only condition, viewing misinformation (i.e. the original incorrect cause, not including correct cause trials) in the retraction + alternative condition, and viewing correct information (i.e. the confirmed cause) in the confirmation condition. Only ERPs to misinformation in the retraction + alternative cause were chosen for a fairer comparison with the retraction only condition. Importantly, all causal words analyzed were repeated the same number of times (twice) during encoding, controlling for familiarity effects. A repeated measures ANOVA revealed a significant condition effect for the retrieval P300, $F(2,94) = 3.51$, $p = 0.034$, $\eta_p^2 = 0.069$ (Fig. 3A and C). Planned comparisons revealed that the confirmation condition ($M = 2.15$ μV, $SE = 0.36$ μV) elicited a significantly higher P300 amplitude than the retraction only condition ($M = 1.00$ μV, $SE = 0.26$ μV), $t(47) = 2.57$, $p = 0.013$, $d = 0.37$, but not higher than the retraction + alternative condition ($M = 1.73$ μV, $SE = 0.31$ μV), $t(47) = 0.84$, $p = 0.405$, $d = 0.12$. Most importantly, the retraction + alternative condition elicited a significantly larger P300 amplitude compared to the retraction only condition when viewing misinformation, $t(47) = 2.02$, $p = 0.049$, $d = 0.29$. This suggests the retraction + alternative condition exhibits a higher level of recollection than the retraction only condition, despite both conditions viewing misinformation during veracity judgement.

The same ANOVA on FN400 revealed a significant difference among conditions, $F(2,94) = 4.20$, $p = 0.018$, $\eta_p^2 = 0.082$ (Fig. 3B and D). Planned comparisons revealed a significantly greater (more negative) amplitude for the confirmation condition ($M = -1.32$ μV, $SE = 0.20$ μV) compared to the retraction only condition ($M = -0.59$ μV, $SE = 0.18$ μV), $t(47) = 2.74$, $p = 0.009$, $d = 0.40$, and the retraction + alternative condition ($M = -0.69$ μV, $SE = 0.20$ μV), $t(47) = 2.14$, $p = 0.038$, $d = 0.31$. However, there was no significant difference between retraction + alternative and retraction only conditions, $t(47) = 0.41$, $p = 0.683$, $d = 0.06$. The differences between confirmation and retraction conditions suggest that greater conceptual fluency is associated with misinformation compared to correct information.

In addition to the primary analyses of interest, we conducted several supplementary analyses. To examine whether providing an alternative also improved recollection of the alternative cause itself, we compared the P300 when participants viewed the correct alternative in the retraction + alternative condition (e.g. final cause "earthquake" in Table 1) to when participants viewed an incorrect cause in the confirmation condition (updated cause "earthquake" in Table 1). Both causes were presented once during encoding, controlling for familiarity effects. However, a paired *t*-test revealed no significant P300 amplitude differences between the two conditions, $t(47) = 0.68$, $p = 0.497$, $d = 0.09$. Thus, there was no evidence that viewing a correct alternative in the retraction + alternative condition improved recollection relative to viewing a false cause in the confirmation condition.

Because visual inspection of the ERPs suggests that the P300 and the FN400 temporally overlapped with each other, we examined whether the peak latencies differed between the components and conditions. We found that the P300 ($M = 680$ ms, $SE = 4$ ms) occurred significantly later than the FN400 ($M = 403$ ms, $SE = 2$ ms), but no differences were observed between conditions. See supplement D for detailed statistics.

Overall, results suggest that providing alternatives may help reduce the CIE by enhancing recollection processes during veracity judgements to misinformation. To further examine this effect, we now analyze EEGs from the encoding task: when participants encoded misinformation retractions and alternatives.

3.3. Encoding: Update-Related ERP

During the encoding update stage, we first examined EEG responses to retraction (merging retraction only and retraction + alternative conditions for the update cause) and to non-retractions (merging the confirmation and alternative only conditions for the update cause). No significant P300 differences in the left parietal region were found between retraction ($M = 1.00$ μV, $SE = 0.22$ μV) and non-retraction ($M = 1.04$ μV, $SE = 0.22$ μV), $t(40) = 0.13$, $p = 0.894$, $d = 0.02$ (Fig. 4A). However, it must be noted that the two conditions also differed in terms of repetition, such that retractions necessarily repeated previous misinformation while non-retractions did not. Therefore, we do not further investigate latency of the P300 during the update stage.

3.4. Encoding: Final Cause EEG

In the final encoding epoch, a 3-level (retraction only vs. retraction + alternative vs. confirmation) repeated measures ANOVA results revealed a significant main effect, $F(2,80) = 21.1$, $p < 0.001$, $\eta_p^2 = 0.346$ (Fig. 4B). Planned comparisons revealed that in the retraction only condition ($M = 4.33$ μV, $SE = 0.30$ μV), seeing the word "unknown" elicited significantly higher P300 amplitude in the left parietal region than in the retraction + alternative condition ($M = 2.10$ μV, $SE = 0.34$ μV), $t(40) = 4.53$, $p < 0.001$, $d = 0.71$, and the confirmation condition ($M = 1.92$ μV, $SE = 0.22$ μV), $t(40) = 7.34$, $p < 0.001$, $d = 1.15$. There was no significant difference in P300 amplitude between the retraction + alternative and confirmation conditions, $t(40) = 0.43$, $p = 0.668$, $d = 0.07$. Once again, repetition effects may account for the P300 differences: in the retraction only condition, the final cause is always "unknown", which may elicit stronger P300 than other conditions. In addition, three out of four conditions (retraction + alternative, confirmation, alternative only) provided a causal word during the final cause stage, meaning that seeing the word "unknown" was a low probability event and may have elicited oddball effects (Picton, 1992). Therefore, we do not further analyze between-condition ERP differences or ERP latency in the final cause encoding stage.

3.5. ERP-behavioral Correlation

To examine potential mechanisms behind the high veracity judgement accuracy in the retraction + alternative condition, we examined the relationship between P300 amplitude during encoding and subsequent accuracy. Although the retraction only and retraction + alternative conditions were merged during the update stage for between-condition ERP analysis, we separated the conditions for correlation analysis because the importance of the update stage for subsequent veracity judgments may differ between conditions. For example, high veracity judgement accuracy in the retraction + alternative but not retraction only condition may require strong encoding of the retraction during the update stage.

In the retraction + alternative condition, there was a positive correlation between update P300 amplitude and accuracy ($r(39) = 0.319$, $p = 0.042$, Fig. 4C), and between final cause P300 amplitude and accuracy ($r(39) = 0.476$, $p = 0.002$, Fig. 4D).

In the retraction only and confirmation conditions, no significant correlations were observed ($ps > 0.05$, $rs < 0.3$, see supplement E). In the veracity judgement task, no significant correlations were found between retrieval P300 amplitude, FN400 amplitude, and veracity judgement accuracy ($ps > 0.05$, $rs < 0.3$, see supplement E).

Results show that greater recruitment of encoding processes during both update cause and final cause stages were associated with improved accuracy during veracity judgement in the retraction + alternative condition, highlighting the role of encoding in improved veracity judgement accuracy in this condition. It is important to note that an alternative interpretation may be that P300 reflects attentional allocation, so accuracy in the retraction + alternative condition may also be

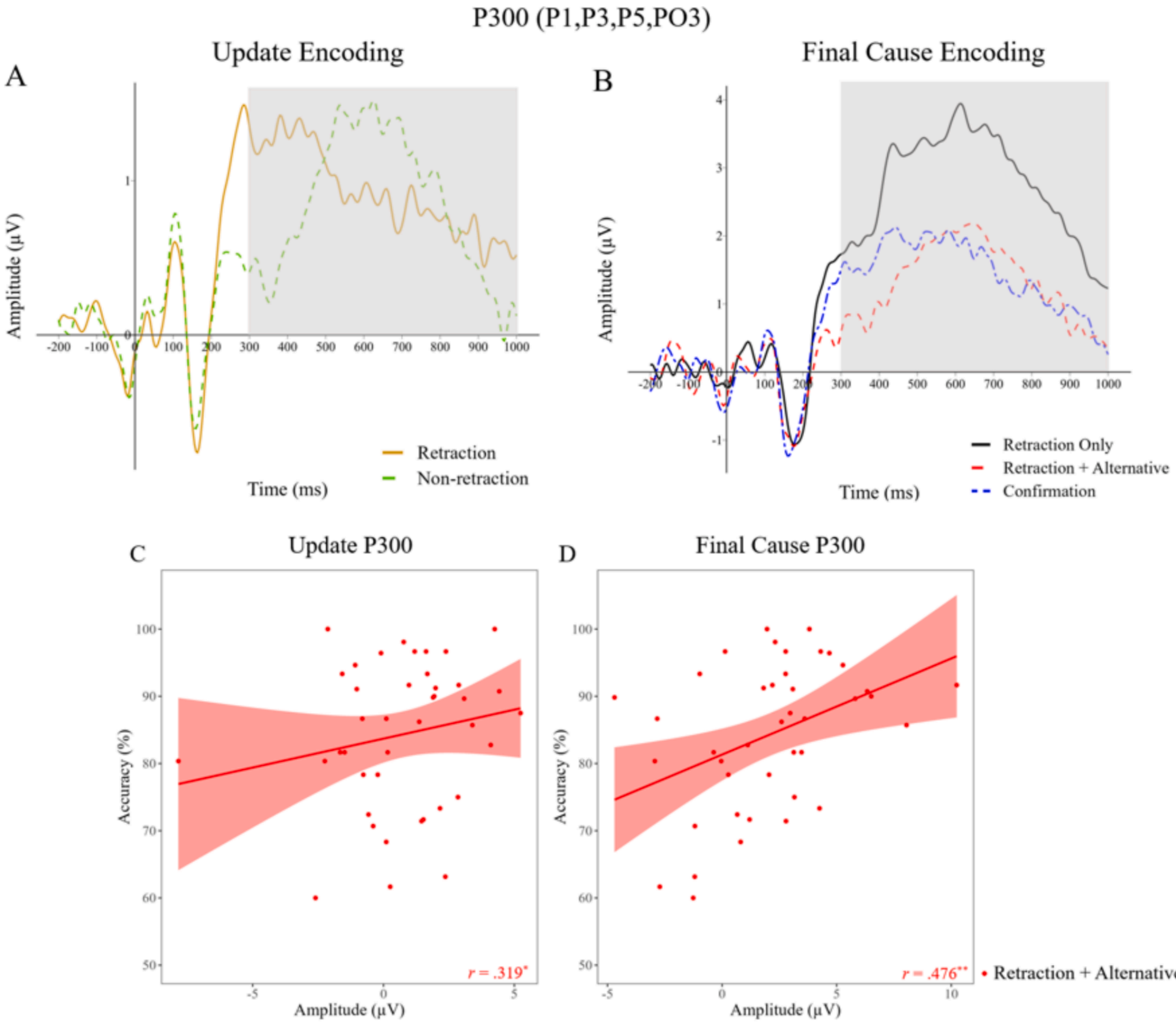

Fig. 4. Grand average ERP waveforms showing activity in the left parietal region during **A.** the update stage, and **B.** the final cause stage. Shaded regions indicate time windows of interest. Graphs showing correlation between veracity judgement accuracy and **C.** Update P300 amplitude **D.** Final cause P300 amplitude in the retraction + alternative condition. Shaded regions indicate 95 % confidence interval. **: $p < 0.01$, *: $p < 0.05$.

contingent upon attention during encoding.

4. Discussion

Misinformation can have long-lasting negative influences on our judgments even when it is retracted, a phenomenon known as the continued influence effect (CIE, Ecker et al., 2022). Consistent with prior research, we found that providing an alternative cause with a retraction significantly reduced the CIE than only providing a retraction, as evidenced by higher accuracies and faster response times in discerning between true and false causes (Ecker et al., 2022; Johnson & Seifert, 1994; Lewandowsky et al., 2012; Wilkes & Leatherbarrow, 1988). Elucidating the underlying neurocognitive mechanisms, we found that misinformation elicited a greater P300 during veracity judgements when it had an alternative explanation, compared to when only a retraction was provided, reflecting improved recollection of contextual information. Moreover, within this retraction + alternative condition, we also found that larger P300 during encoding was associated with higher veracity judgment accuracies, suggesting that effective encoding of both retraction and alternative may be an important prerequisite to reducing the CIE.

Beginning with results of greatest importance, we found that retrieval P300 to misinformation was higher in both retraction + alternative and confirmation conditions than the retraction only condition during veracity judgements. Prior research on memory retrieval suggests that P300 tracks conscious episodic recollection, with higher P300 being associated with richer contextual recall and more episodic details (Allan et al., 1998; Curran, 2000; Finnigan et al., 2002; Voss & Paller, 2009; Yang et al., 2019). Consistent with the selective retrieval model, these results suggested that misinformation with an alternative had improved strategic monitoring processes during subsequent veracity judgements to misinformation (Ayers & Reder, 1998; Butterfuss & Kendeou, 2019; Ecker et al., 2022; Schwarz et al., 2007). Improved strategic monitoring could potentially aid misinformation detection by a recall-to-reject process (Morcom, 2015), where misinformation is labelled as false because a true alternative cause was recollected. However, because many distinct pieces of information were associated with each event (i.e. image, short description, initial and updated cause), it is difficult to determine the precise contents of what is being recollected during veracity judgement.

Events with a confirmed cause have more coherent event models than events without a clear cause (Ecker et al., 2022), which could lead to improved recollection during veracity judgement. This was supported by our findings that viewing a confirmed cause in the confirmation condition elicited a larger P300 than viewing misinformation in the retraction only condition. Overall, P300 results during veracity judgement suggest that alternative explanations facilitate misinformation rejection through strategic monitoring processes.

Examination of FN400 amplitude reflecting conceptual processing fluency (Nie et al., 2021; Strozak, Abedzadeh, & Curran, 2016; Voss et al., 2010) during veracity judgements revealed a less negative FN400 for both misinformation conditions compared to the confirmation condition. This suggested that misinformation was processed with greater conceptual fluency than correct information, providing evidence for claims that misinformation may be preferentially selected due to its increased fluency (Ayers & Reder, 1998). No differences were found between the retraction only and the retraction + alternative condition, suggesting that alternative explanations may not influence subsequent conceptual fluency of misinformation.

Individual difference analyses during the encoding stage provided additional insight into the mechanisms behind the CIE. We found that when alternative causes were provided, larger P300s during encoding (both update and final cause) were associated with more accurate veracity judgements, a critical aspect of the CIE. This suggests that in the retraction + alternative condition, in-depth encoding processes during both the updating and alternative cause stages were integral to veracity judgement. Successful hits may rely on encoding alternatives, and correct rejections may rely on encoding retractions. However, it is also possible that enhanced P300 reflects attentional allocation, suggesting that attention plays an important role when learning new causal information.

The above findings can elucidate mechanisms behind how providing alternative causes could decrease the CIE: an alternative provides boosts strategic monitoring processes during veracity judgement but does not necessarily alter the conceptual fluency of misinformation itself. Comparable FN400 levels suggest similar levels of misinformation fluency between retraction only and retraction + alternative conditions, which means correct alternatives may be encoded alongside misinformation without influencing misinformation activation. The extent to which an alternative improves veracity judgements may be moderated by the level of memory encoding or attention for both retractions and alternatives during encoding: if retractions and alternatives are not paid attention to or are encoded weakly, the CIE persists.

The current study focused on similar ERP components to another EEG-CIE study (Brydges et al., 2020) but contradicts some of their findings. In their study, viewing misinformation elicited increased P300s compared to correct information during veracity judgement. In a similar comparison, our study found that viewing correct information and misinformation that had an alternative enhanced P300s compared to viewing misinformation without an alternative during veracity judgement. This discrepancy between studies could be due to repetition: in Brydges et al., 2020, correct information only appeared one time and was not confirmed or retracted later in the story. However, in our confirmation condition, correct information was shown twice – once initially, and once at the end of the trial as a confirmation, which may have strengthened subsequent recollection. Another contradictory finding lies in the FN400 results. Brydges et al. found that misinformation had a more negative FN400 than correct information. In their study, misinformation was presented twice whereas correct information was presented once during encoding. Based on familiarity accounts of the CIE (Ayers & Reder, 1998; Ecker et al., 2022) and experiments on the FN400 (Nie et al., 2021; Strozak et al., 2016), repeated misinformation should have elicited a less negative FN400. Brydges et al. interpreted the more negative FN400 to misinformation as removal of misinformation from the mental model, rendering it less accessible (Brydges et al., 2020). In our study, we found that FN400 was less negative for misinformation compared to correct information, even when familiarity was controlled between conditions by presenting both misinformation and correct information twice. This provides evidence against the interpretation that misinformation was removed from the mental model and instead supports the selective retrieval account that misinformation may be relied upon due to its increased accessibility and processing fluency (Ayers & Reder, 1998; Lewandowsky et al., 2012). Speculatively, this may have been because retractions in our study led to more in-depth processing of causes than confirmations, resulting in increased activation of misinformation during veracity judgements. However, because baseline familiarity of misinformation and correct information between our study and Brydges et al. differed, the results may not be directly comparable.

Because we designed a new CIE paradigm accommodating EEG analyses, our paradigm differs from classic CIE paradigms as follows: In classical CIE paradigms, an event is typically represented as rich narratives with causes and retractions embedded into them. Events in our study were limited to an image and a short descriptive phrase, and causes were presented as one word. Although the event and phrase may have provided context comparable to classical CIE paradigms, the amount of contextual information contained in the cause word is far less than in a typical misinformation sentence. Therefore, mnemonic processes during veracity judgement only reflect recollection of simplified misinformation compared to what we would expect in the real world. Future EEG CIE research should also seek to use more naturalistic scenarios to investigate neural activity during encoding, like past fMRI CIE studies (Gordon et al., 2017; Jin et al., 2022). We also did not examine how personal worldview and source credibility impact processing of retractions and alternatives, both of which have been shown to highly influence the CIE (Ecker et al., 2022; Lewandowsky et al., 2012). Finally, the interval between encoding the initial cause and its retraction was short (around 4 s), which limits its generalizability to real-life situations, where people may receive retractions days after initial misinformation exposure. Indeed, a meta-analysis found that immediate corrections are more effective than corrections given after a brief filler task (Walter & Tukachinsky, 2020). However, the magnitude of the CIE has also been shown to be similar between immediate and 1-week delayed correction (Ahn et al., 2023). Future research investigating the interaction between alternative explanations and delay may thus be warranted. Despite these differences, we found consistent findings reported in classical CIE research (Johnson & Seifert, 1994): alternative explanations led to higher rates of misinformation rejection than mere retractions.

The current study has limitations that may affect how the above findings can be interpreted. We did not separate correct and incorrect trials in our ERP analyses, as this would lead to many participant exclusions ($n = 40$) due to having fewer than 20 trials in any condition. Even though an exploratory analysis with correct trials only showed the same pattern of results (supplement B), future studies could increase the total trial count and compare neural activity between correct and incorrect veracity judgements to examine underlying mechanisms behind successful retractions and alternative explanations. Also, because a related image was presented before the causal word during veracity judgements, participants may have recalled details of the event prior to word presentation. However, given that they were unable to evaluate the veracity of a cause until it was presented, ERPs time-locked to cause presentation can still provide insights into cause-related strategic monitoring and conceptual fluency processes.

5. Conclusion

By adapting the CIE paradigm for EEG, we illuminate neurocognitive processes during encoding and subsequent veracity judgments of misinformation, focusing on alternative explanations to misinformation. We found that although providing an alternative reduced the CIE via enhancing strategic memory recollection processes during veracity judgement, strong attention to or in-depth encoding of retractions and alternatives was an important prerequisite. To more effectively update false information in memory, merely providing a retraction is not enough – it is important to provide alternatives for people to encode and to retrieve during veracity judgments.

CRediT authorship contribution statement

Sean Guo: Writing – review & editing, Writing – original draft, Visualization, Software, Resources, Methodology, Investigation, Formal analysis, Conceptualization. **Danni Chen:** Writing – review & editing, Validation, Methodology, Conceptualization. **Xiaoqing Hu:** Writing – review & editing, Supervision, Methodology, Funding acquisition, Conceptualization.

Acknowledgements

The authors would like to thank Dr. Jing Liu for methodological suggestions and Nicholas Wong for assistance in data collection. The research was supported by the Ministry of Science and Technology of China STI2030-Major Projects (No. 2022ZD0214100), National Natural Science Foundation of China (No. 32171056), General Research Fund (No. 17614922) of Hong Kong Research Grants Council to X. H.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.bandc.2025.106290.

Data availability

Data is available at https://osf.io/k2my5/.

References

Allan, K., Wilding, E. L., & Rugg, M. D. (1998). Electrophysiological evidence for dissociable processes contributing to recollection. *Acta Psychologica, 98*, 231–252.

Ayers, M. S., & Reder, L. M. (1998). A theoretical review of the misinformation effect: Predictions from an activation-based memory model. *Psychonomic Bulletin and Review, 5*(1), 1–21. https://doi.org/10.3758/BF03209454

Blanc, N., Kendeou, P., Broek, P. Van Den, & Brouillet, D. (2008). Updating situation models during reading of news reports: Evidence from empirical data and simulations. *Discourse Processes*, *45*(2), 103–121. https://doi.org/10.1080/01638530701792784.

Brydges, C. R., & Barceló, F. (2018). Functional dissociation of latency-variable, stimulus- and response-locked target p3 sub-components in task-switching. *Frontiers in Human Neuroscience, 12*. https://doi.org/10.3389/fnhum.2018.00060

Brydges, C. R., Gordon, A., & Ecker, U. K. H. (2020). Electrophysiological correlates of the continued influence effect of misinformation: An exploratory study. *Journal of Cognitive Psychology, 32*(8), 771–784. https://doi.org/10.1080/20445911.2020.1849226

Butterfuss, R., & Kendeou, P. (2019). Reducing Interference From Misconceptions: The Role of Inhibition in Knowledge Revision. *Journal of Educational Psychology*. https://doi.org/10.1037/edu0000385

Chan, M. P. S., Jones, C. R., Hall Jamieson, K., & Albarracín, D. (2017). Debunking: A Meta-Analysis of the Psychological Efficacy of Messages Countering Misinformation. *Psychological Science, 28*(11), 1531–1546. https://doi.org/10.1177/0956797617714579

Curran, T. (2000). Brain potentials of recollection and familiarity. In. *Memory & Cognition* (Vol. 28, Issue 6).

Delorme, A., & Makeig, S. (2004). EEGLAB: An open source toolbox for analysis of single-trial EEG dynamics including independent component analysis. In. *Journal of Neuroscience Methods, 134*. http://www.sccn.ucsd.edu/eeglab/.

Donchin, E. (1981). Surprise!...Surprise? *Psychophysiology, 18*(5), 493–513. https://doi.org/10.1111/j.1469-8986.1981.tb01815.x

Ecker, U. K. H., & Antonio, L. M. (2021). Can you believe it? An investigation into the impact of retraction source credibility on the continued influence effect. *Memory & Cognition, 49*, 631–644. https://doi.org/10.3758/s13421-020-01129-y/Published

Ecker, U. K. H., Hogan, J. L., & Lewandowsky, S. (2017). Reminders and repetition of misinformation: Helping or hindering its retraction? *Journal of Applied Research in Memory and Cognition*, 185–192.

Ecker, U. K. H., Lewandowsky, S., Cook, J., Schmid, P., Fazio, L. K., Brashier, N., Kendeou, P., Vraga, E. K., & Amazeen, M. A. (2022). The psychological drivers of misinformation belief and its resistance to correction. *Nature Reviews Psychology, 1*(1), 13–29. https://doi.org/10.1038/s44159-021-00006-y

Finnigan, S., Humphreys, M. S., Dennis, S., & Geffen, G. (2002). ERP "old/new" effects: Memory strength and decisional factor(s). In. *Neuropsychologia, 40*.

Friedman, D., & Johnson, R. (2000). Event-related potential (ERP) studies of memory encoding and retrieval: A selective review. *Microscopy Research and Technique, 51*(1), 6–28. https://doi.org/10.1002/1097-0029(20001001)51:1<6::AID-JEMT2>3.0.CO;2-R

Gordon, A., Brooks, J. C. W., Quadflieg, S., Ecker, U. K. H., & Lewandowsky, S. (2017). Exploring the neural substrates of misinformation processing. *Neuropsychologia, 106* (September), 216–224. https://doi.org/10.1016/j.neuropsychologia.2017.10.003

Gordon, A., Quadflieg, S., Brooks, J. C. W., Ecker, U. K. H., & Lewandowsky, S. (2019). Keeping track of 'alternative facts': The neural correlates of processing misinformation corrections. *NeuroImage*, *193*(August 2018), 46–56. https://doi.org/10.1016/j.neuroimage.2019.03.014.

Jin, H., Jia, L., Yin, X., Yan, S., Wei, S., & Chen, J. (2022). The neural basis of the continued influence effect of misinformation. *Acta Psychologica Sinica, 54*(4), 343. https://doi.org/10.3724/sp.j.1041.2022.00343

Johnson, H. M., & Seifert, C. M. (1994). Sources of the Continued Influence Effect: When Misinformation in Memory Affects Later Inferences. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 20*(6), 1420–1436. https://doi.org/10.1037/0278-7393.20.6.1420

Kendeou, P., Walsh, E. K., Smith, E. R., & O'Brien, E. J. (2014). Knowledge Revision Processes in Refutation Texts. *Discourse Processes, 51*(5–6), 374–397. https://doi.org/10.1080/0163853X.2014.913961

Kiat, J. E., & Belli, R. F. (2017). An exploratory high-density EEG investigation of the misinformation effect: Attentional and recollective differences between true and false perceptual memories. *Neurobiology of Learning and Memory, 141*, 199–208. https://doi.org/10.1016/j.nlm.2017.04.007

Lee, K., Mirjalili, S., Quadri, A., Corbett, B., & Duarte, A. (2022). Neural Reinstatement of Overlapping Memories in Young and Older Adults. *Journal of Cognitive Neuroscience, 34*(8), 1376–1396. https://doi.org/10.1162/jocn_a_01871

Lewandowsky, S., Ecker, U. K. H., Seifert, C. M., Schwarz, N., & Cook, J. (2012). Misinformation and Its Correction: Continued Influence and Successful Debiasing. *Psychological Science in the Public Interest, Supplement, 13*(3), 106–131. https://doi.org/10.1177/1529100612451018

Lopez-Calderon, J., & Luck, S. J. (2014). ERPLAB: An open-source toolbox for the analysis of event-related potentials. *Frontiers in Human Neuroscience, 8*(1 APR). https://doi.org/10.3389/fnhum.2014.00213

Mecklinger, A. (2010). The control of long-term memory: Brain systems and cognitive processes. *In Neuroscience and Biobehavioral Reviews (Vol., 34*(7), 1055–1065. https://doi.org/10.1016/j.neubiorev.2009.11.020

Mecklinger, A., & Bader, R. (2020). From fluency to recognition decisions: A broader view of familiarity-based remembering. In *Neuropsychologia* (Vol. 146). Elsevier Ltd. https://doi.org/10.1016/j.neuropsychologia.2020.107527.

Mecklinger, A., Johansson, M., Parra, M., & Hanslmayr, S. (2007). Source-retrieval requirements influence late ERP and EEG memory effects. *Brain Research, 1172*(1), 110–123. https://doi.org/10.1016/j.brainres.2007.07.070

Morcom, A. M. (2015). Resisting false recognition: An ERP study of lure discrimination. *Brain Research, 1624*, 336–348. https://doi.org/10.1016/j.brainres.2015.07.049

Morey, R. D. (2008). Confidence intervals from normalized data: a correction to cousineau (2005). *Tutorials in Quantitative Methods for Psychology, 4*(2), 61–64. 10.20982/tqmp.04.2.p061.

Nie, A., Pan, R., & Shen, H. (2021). How Processing Fluency Contributes to the Old/New Effects of Familiarity and Recollection: Evidence From the Remember/Know Paradigm. *American Journal of Psychology, 134*(3), 297–319. https://doi.org/10.5406/amerjpsyc.134.3.0297

Nielsen, K., & Gonzalez, R. (2020). Comparison of Common Amplitude Metrics in Event-Related Potential Analysis. *Multivariate Behavioral Research, 55*(3), 478–493. https://doi.org/10.1080/00273171.2019.1654358

Peirce, J., Gray, J. R., Simpson, S., MacAskill, M., Höchenberger, R., Sogo, H., Kastman, E., & Lindeløv, J. K. (2019). PsychoPy2: Experiments in behavior made easy. *Behavior Research Methods, 51*(1), 195–203. https://doi.org/10.3758/s13428-018-01193-y

Picton, T. W. (1992). The P300 wave of the human event-related potential. *Journal of Clinical Neurophysiology, 9*(4), 456–479. https://doi.org/10.1097/00004691-199210000-00002

Pion-Tonachini, L., Kreutz-Delgado, K., & Makeig, S. (2019). ICLabel: An automated electroencephalographic independent component classifier, dataset, and website. *NeuroImage, 198*, 181–197. https://doi.org/10.1016/j.neuroimage.2019.05.026

Polich, J. (2007). Updating P300: An integrative theory of P3a and P3b. *In Clinical Neurophysiology (Vol., 118*(10), 2128–2148. https://doi.org/10.1016/j.clinph.2007.04.019

Rac-Lubashevsky, R., & Kessler, Y. (2019). Revisiting the relationship between the P3b and working memory updating. *Biological Psychology*, *148*(September), 107769. https://doi.org/10.1016/j.biopsycho.2019.107769.

Rugg, M. D., & Curran, T. (2007). Event-related potentials and recognition memory. *Trends in Cognitive Sciences, 11*(6), 251–257. https://doi.org/10.1016/j.tics.2007.04.004

Schwarz, N., Sanna, L. J., Skurnik, I., & Yoon, C. (2007). Metacognitive Experiences and the Intricacies of Setting People Straight: Implications for Debiasing and Public Information Campaigns. In *Advances in Experimental Social Psychology* (Vol. 39, pp. 127–161). https://doi.org/10.1016/S0065-2601(06)39003-X.

Strozak, P., Abedzadeh, D., & Curran, T. (2016). Separating the FN400 and N400 potentials across recognition memory experiments. *Brain Research, 1635*, 41–60. https://doi.org/10.1016/j.brainres.2016.01.015

Strozak, P., Bird, C. W., Corby, K., Frishkoff, G., & Curran, T. (2016). FN400 and LPC memory effects for concrete and abstract words. *Psychophysiology, 53*(11), 1669–1678. https://doi.org/10.1111/psyp.12730

Swire-Thompson, B., Dobbs, M., Thomas, A., & DeGutis, J. (2023). Memory failure predicts belief regression after the correction of misinformation. *Cognition, 230*. https://doi.org/10.1016/j.cognition.2022.105276

Volz, K., Stark, R., Vaitl, D., & Ambach, W. (2019). Event-related potentials differ between true and false memories in the misinformation paradigm. *International Journal of Psychophysiology, 135*, 95–105. https://doi.org/10.1016/j.ijpsycho.2018.12.002

Voss, J. L., & Paller, K. A. (2009). Remembering and knowing: Electrophysiological distinctions at encoding but not retrieval. *NeuroImage, 46*(1), 280–289. https://doi.org/10.1016/j.neuroimage.2009.01.048

Voss, J. L., Schendan, H. E., & Paller, K. A. (2010). Finding meaning in novel geometric shapes influences electrophysiological correlates of repetition and dissociates perceptual and conceptual priming. *NeuroImage, 49*(3), 2879–2889. https://doi.org/10.1016/j.neuroimage.2009.09.012

Wilkes, A. L., & Leatherbarrow, M. (1988). Editing Episodic memory following the identification of error. *The Quarterly Journal of Experimental Psychology Section A, 40*(2), 361–387. https://doi.org/10.1080/02724988843000168

Yang, H., Laforge, G., Stojanoski, B., Nichols, E. S., McRae, K., & Köhler, S. (2019). Late positive complex in event-related potentials tracks memory signals when they are decision relevant. *Scientific Reports, 9*(1). https://doi.org/10.1038/s41598-019-45880-y