Emotions in Misinformation Studies: Distinguishing Affective State from Emotional Response and Misinformation Recognition from Acceptance

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Prior studies indicate that emotions, particularly high-arousal emotions, may elicit rapid thinking, decreasing the ability to recognize misinformation. Yet, few studies have distinguished prior affective states from emotional reactions to false news, which could influence belief in falsehoods in different ways. Replicating and extending Martel et al. (2020), we conducted a pre-registered online survey in Austria ($N = 422$), investigating associations of emotions and discernment of false and real news related to COVID-19. We found no associations of affective state with discernment but higher anger and less joy in response to false than real news. Exploratory analyses, including automated analyses of open-ended text responses, suggested that higher anger was often related to recognizing the misinformation in our educated and left-leaning sample. We conclude that studies need to distinguish between prior affective state and emotional response to misinformation and consider individuals' prior beliefs as determinants of emotions.

Keywords: misinformation, emotion, anger, discernment, recognition, belief, COVID-19

Misinformation is said to maximally elicit emotion and trigger reactions such as commenting or sharing online. High-arousal emotions, such as anxiety and anger, may hinder critical reflection and elicit rapid, intuitive thinking—leaving people vulnerable to misinformation (Berger & Milkman, 2013; Boyer, 2021; Weeks, 2015). As a consequence, people accept inconsistencies or deliberate lies. To analyze the relationship between emotions and misinformation, observational (Chuai & Zhao, 2022; Pröllochs et al., 2021; Zollo et al., 2015) and experimental studies (Greenstein & Franklin, 2020; Martel et al., 2020) have measured aggregate emotions across individuals and various situations. Yet, earlier studies have failed to distinguish between emotions originating in the person from those elicited by the stimulus (Van Damme & Smets, 2014), that is, the effect of general emotional state (mood) and emotional responses to the content. Additionally, the function of emotions depends on the

context: Identical content can cause different emotions for different reasons, often depending on people's prior beliefs (Mercier, 2020).

We investigated the association of emotions with the recognition of false and real news, differentiating between the affective state and direct emotional responses. In our pre-registered, confirmatory analyses, we conceptually replicated and extended study 1 from Martel et al. (2020). Additionally, we explored direct emotional responses to the news and prior beliefs about the news topic. As vaccines were introduced in Austria in 2021, we conducted an online survey using COVID-19 news stories in a sample recruited by Austrian university students (N=422). Unlike the study by Martel et al. (2020), we found no significant negative correlation between misinformation discernment and prior affective state. Exploratory analyses of direct emotional responses to false and real news showed that most participants felt significantly more angry after exposure to false news, while they reported higher joy in response to real news. The analysis of open-ended responses illustrated that anger arose for different reasons in different participants: While some seemed angry because they believed the content of false news, others expressed anger about the existence of such news. Indeed, a curvilinear relationship between news discernment ability and elicited emotions confirmed this: Both lower and higher discernment abilities co-occurred with higher anger. Among all emotional responses, only anxiety was negatively associated with discernment.

Overall, our results suggest that emotions do not simply enhance susceptibility to misinformation. Instead, the association of elicited emotions with information processing depends on context-specific factors, such as the origin of the emotion (person vs. news) or the person's prior beliefs. We advocate for studies in communication science and psychology to consider people's reasons for feeling the emotion, as well as the origin and timing of emotions.

Emotions and Misinformation Belief

One dominant perspective on misinformation belief in cognitive psychology originates from information processing theory (Ecker et al., 2022; Pennycook & Rand, 2021). It suggests that people can make accurate judgments based on information characteristics, like its coherence with prior knowledge (Schaewitz et al., 2020). However, this process demands high cognitive effort and is often constrained by limited cognitive capacity (Lang, 2000). Consequently, when motivation to engage in analytical thinking is low, people tend to process information heuristically. According to this perspective, emotions oppose logical thinking, adversely affecting individuals' judgment (Holland et al., 2012; Martel et al., 2020). Emotional information is shared more often, especially when emotions rate higher on arousal (Berger, 2011; Berger & Milkman, 2013). Information eliciting negative emotions can also increase susceptibility to partisan arguments aligning with prior beliefs (Weeks & Garrett, 2019). Beyond content emotionality, according to the mood-as-information model, people may use their affective state as information to make evaluative judgments, leading to a misattribution of the mood to the information under evaluation (Schwarz, 2001).

An alternative perspective on how emotions influence misinformation belief is the evolutionary theory of communication. It suggests that communication signals, including emotions, have to benefit both the sender and receiver to evolve. There have to be mechanisms that prevent senders from routinely deceiving and exploiting receivers, that is, signals have to be (mostly) honest (Mercier, 2021; Sperber et al., 2010). In this framework, people are skeptical by default (Altay, 2022; Mercier, 2017), and only trust information if it passes several trustworthiness checks (Dezecache & Mercier, 2022; Mercier, 2021; Sperber et al., 2010). Information that aligns with our prior beliefs, comes from a trusted source, or provides good arguments, has a higher chance of acceptance (Mercier, 2017, 2021). From this

perspective, the adaptive function of the emotion in a specific context is central to understanding its role. As such, emotion in misinformation is not contagious but interacts with the consumer's prior beliefs to determine the elicited emotions (Mercier, 2020). For instance, encountering information that threatens a worldview associated with an individual's social identity (Robertson et al., 2022) may trigger intense negative emotions and identity-protective mechanisms like the rejection or biased information selection (Knobloch-Westerwick et al., 2020; Lewandowsky & Oberauer, 2016; Wischnewski & Krämer, 2021).

Affective State and Misinformation Perception

Martel and colleagues (2020) were the first to show that increased positive and negative emotions before exposure to political misinformation are associated with false news being rated as more accurate, but not with ratings of real news. In a second study, they showed that focusing on emotions rather than reason decreased discernment between real and false news. Our goal was to test if the association of increased affective state with misinformation discernment, reported in study 1 by Martel et al. (2020), could be replicated in a different context. Specifically, we tested if the results generalize beyond the American context and to COVID-19-related misinformation. Health misinformation may differ from other (political) misinformation in terms of sentiment and diffusion (Pröllochs et al., 2021) and can be less persistent when not associated with people's social identity (Vraga et al., 2019; Walter & Murphy, 2018). Nevertheless, due to the political polarization of COVID-19-related health (mis)information and the high emotional involvement with this topic, we expected no substantial differences to the topic of US politics. We therefore expected stronger emotions reported before news exposure to correlate negatively with discernment of false and real

news measured in an accuracy rating task (H1). We expected this to hold for both negative (H2a) and positive emotions (H2b), but to be more pronounced for negative emotions (H2c).

High-arousal emotions, both positive and negative, boost information sharing (Berger, 2011; Berger & Milkman, 2013). Specifically, emotions like anger may boost intuitive thinking and rapid decision-making and make deliberation less likely, thus enhancing susceptibility to misinformation (Greenstein & Franklin, 2020). This leaves individuals vulnerable to misinformation consistent with their prior political beliefs (Weeks, 2015). However, arousal has also been suggested to enhance the memorization of accurate information and reduce the tendency to endorse misinformation (Van Damme & Smets, 2014). To help clarify the role of arousal, we measured arousal as a separate dimension of emotion (Russell, 1980). We predicted that arousal is associated with decreased discernment of news accuracy (H3).

Focusing on valence and arousal as dimensions of emotions has limitations—it does not explain how emotions with similar valence or arousal levels lead to different cognitive appraisals and serve different roles in information processing (Nabi, 2010). Anxiety and anger, commonly suspected to impact misinformation belief, are both negative and high in arousal, but differently associated with risk-taking behavior and information-seeking (Valentino et al., 2008; Wollebæk et al., 2019). While anxiety has been linked to higher acceptance of new information (Brader et al., 2008; Weeks, 2015), anger leads to an aversion to new information (MacKuen et al., 2010) and promotes the use of heuristics in information processing (Bodenhausen et al., 1994). Therefore, both anger and anxiety can leave people susceptible to misinformation in different situations—when exposed to partisan misinformation or when accurate information is lacking, respectively (Freiling et al., 2021; Greenstein & Franklin, 2020; Han et al., 2020). Thus, we further investigated if anger (H4) and anxiety (H5) were associated with decreased discernment of real and false news.

Emotional Response to News

While the mood-as-information model argues for accounting for an individual's affective state prior to exposure, proponents of the emotion flow hypothesis (Nabi, 2015; Nabi & Green, 2015) believe that it is vital to not only study the affective state, but also look at how emotions evolve over time as we are exposed to a message. Additionally, Van Damme and Smets (2014, p. 318) have suggested differentiating between the emotion "in the stimulus" (like a headline or news article) and the emotion "in the person," as the same content may evoke very different emotional reactions in audiences based on their prior experiences, social group affiliations, and more. In addition to the pre-registered hypotheses (https://osf.io/2r6bj/?view_only=f97724186f1540cbbc8187cb79d61cef), we therefore explored emotional responses to real and false news items. In this paper, we thus studied two emotional experiences in the person — measured prior to exposure (affective state) and post-exposure (emotional response).

Methods

Design

This study was an online survey assessing the relationship between misinformation susceptibility (discernment of news items and agreement with false beliefs about COVID-19) and emotions. The study design was approved by the ethics committee of the University of Graz (reference number: 00666) and carried out in accordance with the Declaration of Helsinki. The survey largely followed the design of Martel et al. (2020) but used COVID-19-related news instead of political news. After completing self-reported questionnaires on affective state and agreement ratings for beliefs about COVID-19, all participants rated the accuracy of real and false COVID-19-related news items (n=24,

within-subject). Additionally, they rated their emotional response to each news item for four basic emotions and expressed their first thoughts in an open-text question.

Sample

Participants were recruited by university students taking a research seminar. 718 participants started the survey. Only participants who completed the main part of the survey (ending with the news rating items) were included in the analyses. Following the pre-registration, we excluded 248 incomplete responses and 24 underage participants. The reported measures were part of a larger and longer study (see SI for a list of all questionnaires), which took participants a median of 47 minutes to complete, with 82% needing more than 30 minutes. To maintain response quality, we removed 24 participants who were too quick (< 20 minutes). In addition, we checked for repeated response patterns and straightliners, but did not detect any. The final sample contained 422 participants, on average 33.97 years old (SD = 15.00); 58.43% identified as female and 40.62% as male. Most participants had completed higher education, with 51.68% having a high school degree and 34.62% having a university degree. Only 4 participants indicated right-wing political orientation. Proportions were: 1.1% right, 8.8% center-right, 21.12% center, 47.59% center-left, and 21.66% left (in total, 36 participants right from center, 259 left from center). See Table S1 for more sample descriptives.

Procedure

The online survey began with demographic questions, followed by 5 attitude and personality questionnaires (see SI for complete list) only analyzed in student projects. After completing self-reports of affective state during the last few days, participants rated their agreement with 9 statements describing common beliefs about COVID-19. The news rating task with 12 false

and 12 true news items about COVID-19 followed. After each news item, an open-ended question provided the possibility to express any first impulses and thoughts about it. Next, participants rated the accuracy of the news item, the confidence in their judgment, familiarity with the news content, and reported if the item triggered any emotion in them. If this was the case, they rated how much they were experiencing four different basic emotions (see below). After the news rating task, participants completed a few more questions about vaccination status and media use. Participants were debriefed at the end of the survey.

Measures

Independent measures

Affective state. Participants reported how they felt in the past few days using the German version of the 20-item Positive and Negative Affect Schedule scale (PANAS; see Breyer & Bluemke, 2016). The PANAS scale does not include all relevant basic emotions, nor enough items that indicate high or low arousal. Therefore, we extended the PANAS scale with 6 additional adjectives (sad, surprised, happy, angry, relaxed, and stressed). Participants rated the intensity with which they experienced each emotion on a 5-point Likert scale ranging from ‘Not at all’ to ‘Extremely’. We analyzed relationships of aggregate positive and negative emotions, arousal as well as individual emotions.

Valence. We calculated factor scores via a varimax rotation on a two-factor analysis of all PANAS items, resulting in aggregated scores for positive and negative emotions. For H1, we only examined the original 20 items that were part of the PANAS scale. Specifically, we were looking for overall trends in positive and negative emotions in the PANAS being associated with decreased discernment and accuracy judgments, rather than a specific score. For H2a and H2b, we analyzed the aggregated PANAS scores for all affective state items (original

PANAS items + 6 additional adjectives). Whenever we refer to valence in our confirmatory analyses, we refer to these extended positive and negative PANAS scores.

Arousal. To calculate arousal scores, we took arousal scores for each emotion adjective from the NRC VAD Lexicon (Mohammad, 2018), multiplied them with each participant's rating for that adjective, and took the mean across these values per participant.

Dependent Measures

Agreement with false COVID-19 beliefs. We assessed agreement with 9 common false beliefs about COVID-19 (see SI), including vaccine safety and effectiveness (5), nutrition (1), the immune response (1), masks (1), and gargle tests (1). An example statement is: "Masks threaten the health of children." Participants were asked: "On a scale from 0% to 100%, how much do you agree that this statement is true?" After reverse-coding one real statement (all others were false), we calculated an average per participant (M = 21.56, SD = 19.27, Cronbach's α = .86).

News accuracy rating performance. Like in Martel et al. (2020), the 24 news items (12 false, 12 real) resembled a regular social media post with a picture, headline, byline and source (see Figure 1). False headlines were collected from Austrian and German fact-checking websites about 1-2 months before the survey (www.mimikama.at, https://apa.at/faktencheck/ueberblick/, https://correctiv.org/faktencheck/, https://www.br.de/nachrichten/faktenfuchs-faktencheck), and real news from Austrian mainstream news sites (e.g. DerStandard, Die Presse, Krone). The false items reported on alleged side-effects of preventive healthcare measures and Big Pharma conspiracies. The real items described the benefits and safety of COVID-19 drugs and vaccines, the consequences of vaccine skepticism, updates about new risk factors and virus variants, as well as an initial

lack of protective gear. The order of news items was randomized across participants. For each item, participants answered the question: “To the best of your knowledge and belief, how accurate is this news?” on a 0-100% sliding scale (in increments of 10%; initial cursor was set at 50%). We report accuracy rating performance for real (M = 67.04, SD = 15.29, Cronbach’s α = .80) and false items (M = 22.97, SD = 16.24, Cronbach’s α = .86), as well as discernment between the two (difference in ratings).

Figure 1. Example news item with headline, teaser, picture and news source.

Open-text description of first impulse or thought upon reading a news item. Immediately after each news item, respondents answered: “What impulse or thought does this news trigger in you?”. In total, there were 5,613 textual responses to news items, including 27,468 words (of which 14,224 were in reaction to false and 13,244 to real items). The text was not preprocessed before the analysis with the most recent Linguistic Inquiry and Word Count software (LIWC-2022) using the German dictionary from 2015 (Meier et al., 2019).

Emotional responses. After each news item, participants were asked whether they were experiencing any emotion (6-point scale from 'not at all' to 'strong'). Participants who reported experiencing an emotion (93.4%) were subsequently asked how much they experienced each of the four basic emotions (anger, anxiety, sadness, joy) or any other emotion. Each emotion was described with 2 adjectives in order to measure each emotion more broadly than with just one specific adjective: upset/angry, frightened/uncertain, sad/concerned, happy/excited. Emotional responses, averaged across news items and participants, were relatively low: M_{anger} = 0.93 (SD = 0.94), $M_{anxiety}$ = 0.49 (SD = 0.63), $M_{sadness}$ = 0.64 (SD = 0.73), M_{joy}= 0.28 (SD = 0.47).

Pilot Study

32 students, who also recruited participants later, served as test participants for our study design and items. We examined news rating accuracy for 31 items, agreement with 13 false COVID-19 statements, and the five emotional response items. Overall, the study duration was too long. We decided to reduce it by removing unclear items based on student feedback, and excluding items with a posterior reliability below .75, and the following thresholds for discriminatory power: For news items, we set a somewhat lower-than-usual minimal threshold at > .25 due to the small sample size, thereby excluding 3 false and 4 real news stimuli. For COVID-19 belief statements, we removed 4 real items with discriminatory power < .30. The number of items for the final data collection was 24 news items and 9 statements with acceptable internal consistencies (>.75).

Statistical Analyses

To account for the repeated measurement, and random variance between participants and news items, we used linear mixed-effects models. For confirmatory analyses, we predicted

accuracy ratings from news type, affective state, and their interaction as fixed effects. As random effects, we used intercepts for participants and news items, and a slope for news type (see SI for more details). We ran one model for each of the 26 emotion adjectives, and for each aggregate score for positive and negative valence, and arousal. For confirmatory hypotheses H2 to H5, we used Bonferroni-Holm correction for a total of 5 hypotheses (positive, negative, arousal, anger, anxiety) for each dependent variable (news accuracy rating performance, agreement with false COVID-19 beliefs). For this, hypotheses are ordered starting with the smallest p-value, and then compared to the thresholds of $\alpha = \{.01, .0125, .0167, .025, .05\}$.

Our exploratory analyses used linear mixed-effects models to examine emotional responses to the news, and their interaction with discernment abilities and prior beliefs. All exploratory models included random intercepts per participant (1|participant). If applicable and models converged, they also included a random intercept per news item (1|item). First, we ran a model *emotional response ~ news type + 1|participant + 1|item* for each of the 4 basic emotions to test differences in emotional responses to false and real news. Second, we explored how emotional responses depend on discernment abilities (*emotional response ~ accuracy rating*news type + (1|participants*). Finally, we explored how the emotional response to news differs depending on participants' agreement with false COVID-19 beliefs (e.g., *anger ~ false beliefs * news type + 1|participants*; see SI for details).

Pre-registration and Deviations

The pre-registration is available at https://osf.io/2r6bj/?view_only=f97724186f1540cbbc8187cb79d61cef. C.K. organized the data collection as part of an undergraduate psychology course in December 2021 at the University of Graz in Austria. She only provided the data to the authors writing the

pre-registration after its registration on the OSF on January 20, 2022. The authors received no information about the data prior to the pre-registration.

The pre-registration focused on correlations of affective state prior to news exposure with performance. Beyond correlations with news discernment, H2-H5 were also pre-registered for a second variable, agreement with common COVID-19-related false beliefs (see SI for results). The pre-registration further mentions planned analyses for sadness prior to news exposure, emotional responses to the news items, and prior beliefs moderating these reactions. Yet, except for sadness, these analyses were not sufficiently specified (McPhetres, 2020) and are therefore referred to as exploratory.

Regarding deviations, the pre-registration falsely mentions 31 instead of 24 news items and 11 instead of 9 statements about COVID-19 beliefs (the numbers from the pilot test). We had to omit the planned exploratory analyses on vaccination status and political orientation because there were too few unvaccinated (4.5%) and right-leaning participants (~8.5%), and analyses on minority status because a majority of participants (79.6%) considered themselves part of a minority, suggesting that the item was phrased too broadly. Finally, we need to mention that we used the shortest reference time period (‘the last few days’) provided in the default instructions of the German PANAS questionnaire (Breyer & Bluemke, 2016). We only noticed later that Martel et al. (2020) had asked participants about their emotions “at this moment”.

Results

On average, participants were quite good at accurately judging false (M=22.97, SD=16.24) and real news (M=67.04, SD=15.29). Their affective state self-reports were neutral, that is, exactly in the middle of the scale (M=2.49, SD=0.68 across all emotions). Emotional

responses to news items were quite low overall (false: M = 0.65, SD = 0.87; real: M = 0.52, SD = 0.60). Tables S2/3 provide descriptive statistics for all main variables.

Confirmatory Analyses: Affective state

In part I, we conceptually replicated Martel et al.'s (2020) analyses on the relationship between affective state and news accuracy ratings (H1). In part 2 (H2-H5), we extended these analyses with additional emotion adjectives, and specifically focused on valence, arousal, anger, and anxiety. Table 1 summarizes these results on affective state, and Table S4 additionally provides 95% CIs, t-values, and standard errors for beta coefficients. Based on Martel et al. (2020)'s results, we predicted increased affective state to correlate with decreased accuracy performance both for false news and discernment (difference false vs. real news). We expected this correlation for aggregate positive and negative scores and most single PANAS adjectives (H1, see https://osf.io/2r6bj/?view_only=f97724186f1540cbbc8187cb79d61cef). Martel et al. observed 35 significant coefficients in total: Both aggregate scores and 16 out of 20 adjectives significantly and negatively predicted performance for false news and discernment scores, showing that the effect was specific to false news. Overall, our pattern of results did not support this pattern (H1). We only found two significant coefficients in the predicted direction ("jittered", "afraid") for false news, and none for discernment. "Inspired" had significant coefficients in the opposite direction. Out of both aggregate PANAS scores, only negative affective state was weakly correlated with false news ratings (b = 1.57, p = .048), but not with discernment (b = -0.55, p = .45). However, this association was not as consistent across adjectives as the correlation between positive or negative affective state and accuracy judgements of false news in Martel et al. (2020) (See Figure 2). Additionally, when we expanded the aggregate scores with 6 adjectives (H2), this association with negative emotion

was no longer significant (b = -.55, p = .49), nor was the one with discernment (b = 1.36, p = .24). Coefficients for positive emotions with additional adjectives (H2b) were also not significant, nor were those for arousal (H3, false: b = .04, p = .14 ; real: b = -0.01, p = .6; discernment: b = -0.05, p = .17).

Table 1. Association of affective state ratings with accuracy ratings for each news type (fake, real) and difference in associations between fake and real news (discernment)

	Active	*Distressed*	Interested	*Excited*	*Upset*	*Strong*
False	*0.37*	*1.01*	-1.21	*-0.85*	*0.54*	*-0.44*
Real	-0.50	0.17	0.74	0.01	0.81	0.56
Discernment	*-0.87*	*-0.84*	1.95	*-0.86*	*0.26*	*1.00*

	Guilty	*Scared*	*Hostile*	***Inspired***	*Proud*	*Irritable*
False	*0.53*	*1.17*	*-0.78*	*-2.41***	*0.47*	*1.21*
Real	0.79	-0.40	0.32	1.02	0.07	1.38
Discernment	*0.25*	*-1.56*	*1.10*	*3.43***	*-0.40*	*0.17*

	Enthusiastic	*Ashamed*	*Alert*	*Nervous*	*Determined*	Attentive
False	*-0.56*	*1.29*	*0.76*	*1.59*	*-0.29*	-0.98
Real	1.20	0.43	*-0.62*	-0.25	0.32	*0.64*
Discernment	*1.76*	*-0.86*	-1.38	*-1.84*	0.62	1.63

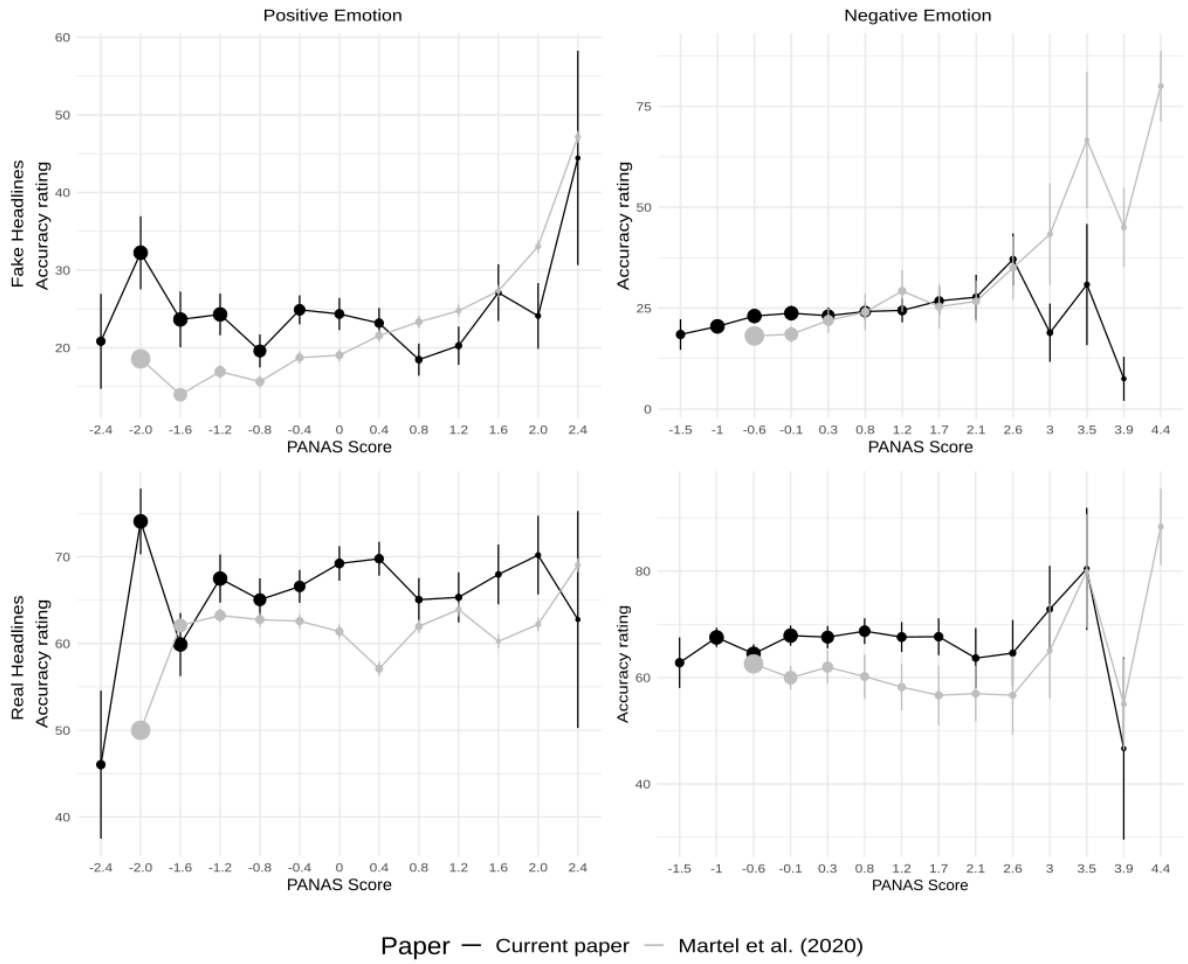
	Jittery	*Afraid/ Anxious*	*Positive PANAS*	*Negative PANAS*	Sad	Surprised
False	*2.12***	*1.81**	*-0.68*	*1.57**	0.82	2.23**
Real	0.49	-0.07	0.62	0.70	0.30	0.00
Discernment	*-1.63*	*-1.88*	*1.30*	*-0.87*	-0.52	-2.23

	Happy	Angry	Relaxed	Stressed	Positive (extended)	Negative (extended)
False	-0.81	1.11	-0.87	-0.30	1.52	-0.55
Real	1.45	0.00	0.77	1.62*	0.64	0.80
Discernment	2.26	-1.11	1.64	1.92	-0.88	1.36

Note. Unstandardized beta coefficients from linear mixed effects models for each emotion: *accuracy ~ emotion + news type + emotion:news type*. False/Real = beta coefficients for the correlation between increased affective state and accuracy ratings for false/real news; Discernment = interaction between emotion and news type.
Significance levels: * <.05, **<.01.
Italic: Significant in Martel et al. (2020), see Table 1.

We had further hypothesized that anger and anxiety decrease accuracy judgments. Yet, coefficients for anger were not significant (H4, false: b = 1.11, p = .16; real: b = 0.001, p = .99; discernment: b = -1.11, p = .33). In contrast, higher anxiety correlated with rating false news items as more accurate (H5, b = 1.81, p = .02), but this relationship was not significant after the pre-registered Bonferroni-Holm correction. Anxiety coefficients for real news (b = -0.07, p = .92) and discernment (b = -1.88, p = .1) were not significant. We repeated all above analyses with prior false beliefs about COVID-19 as a second dependent variable. Again, no consistent correlation pattern emerged between affective state and agreement ratings (see Table S5).

Figure 2. Relationship between news accuracy rating and aggregated positive or negative PANAS scores.



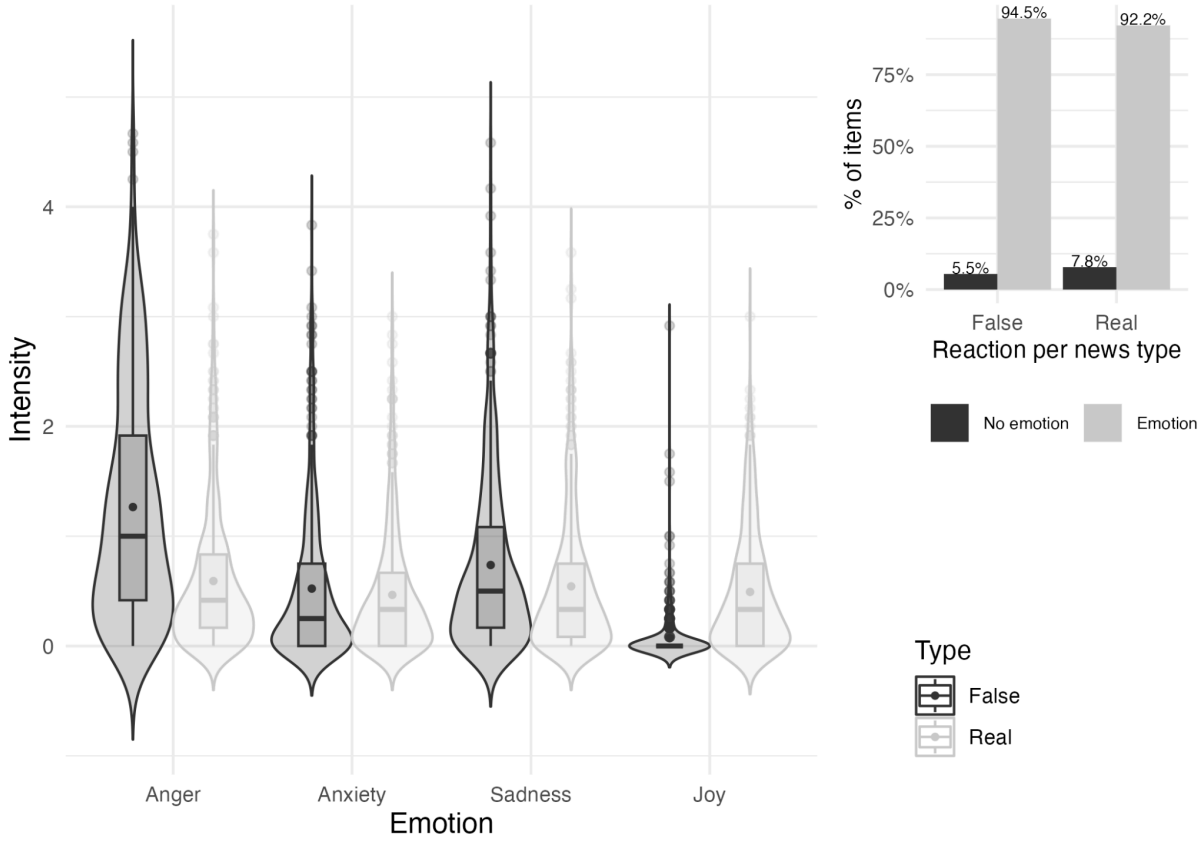
Exploratory Analyses: Responses to False and Real News

We explored the relationship between emotional response and misinformation discernment in three ways: First, we compared immediate emotional responses to false and real news and correlated these reactions with discernment. Second, we counted the frequency of angry words (as defined by the LIWC-2015 anger dictionary) participants expressed in an open-text question about their first impulse and thoughts about each item. Third, we analyzed how emotional responses to news items change with participants' agreement with false beliefs about COVID-19.

Emotional Responses

Overall, most participants experienced an emotional reaction to news compare to feeling no emotion (93.4% of participants in total). Compared to feeling no emotion, 94.5% of participants indicated an emotional reaction to false news; similarly, 92.18% participants indicated one to real news.(see upper right panel in Figure 3 for proportions of emotional reactions to fake vs. real news). For all emotional response ratings (upset/angry, frightened/uncertain, sad/concerned, happy/excited), the models converged, but only the model predicting anger from news type showed a significant difference in means, such that anger levels were .67 points higher for false than real items (b=0.44, [0.24, 0.64], t = 4.31, $p < .001$). On a 6-point scale, this is a substantial difference, and the standardized coefficient also indicates a considerable association. There was a similar but weaker and non-significant pattern for sad/concerned (b = 0.16, 95%CI[-0.04, 0.35], t = 1.59, $p = .111$) and frightened/uncertain (b = 0.05, [-0.09, 0.29], t = 0.74, $p = .457$), although here, the differences were not significant at the alpha-level of .05. Only ratings for joy (happy/excited) were lower for false compared to real items (b = -0.46, [-0.75, -0.18], t = -3.17, $p = .002$).

Figure 3. Differences in emotions after fake vs. real news exposure. A) emotion intensity ratings. B) % of items for which participants indicated feeling an emotion (vs. no emotion).

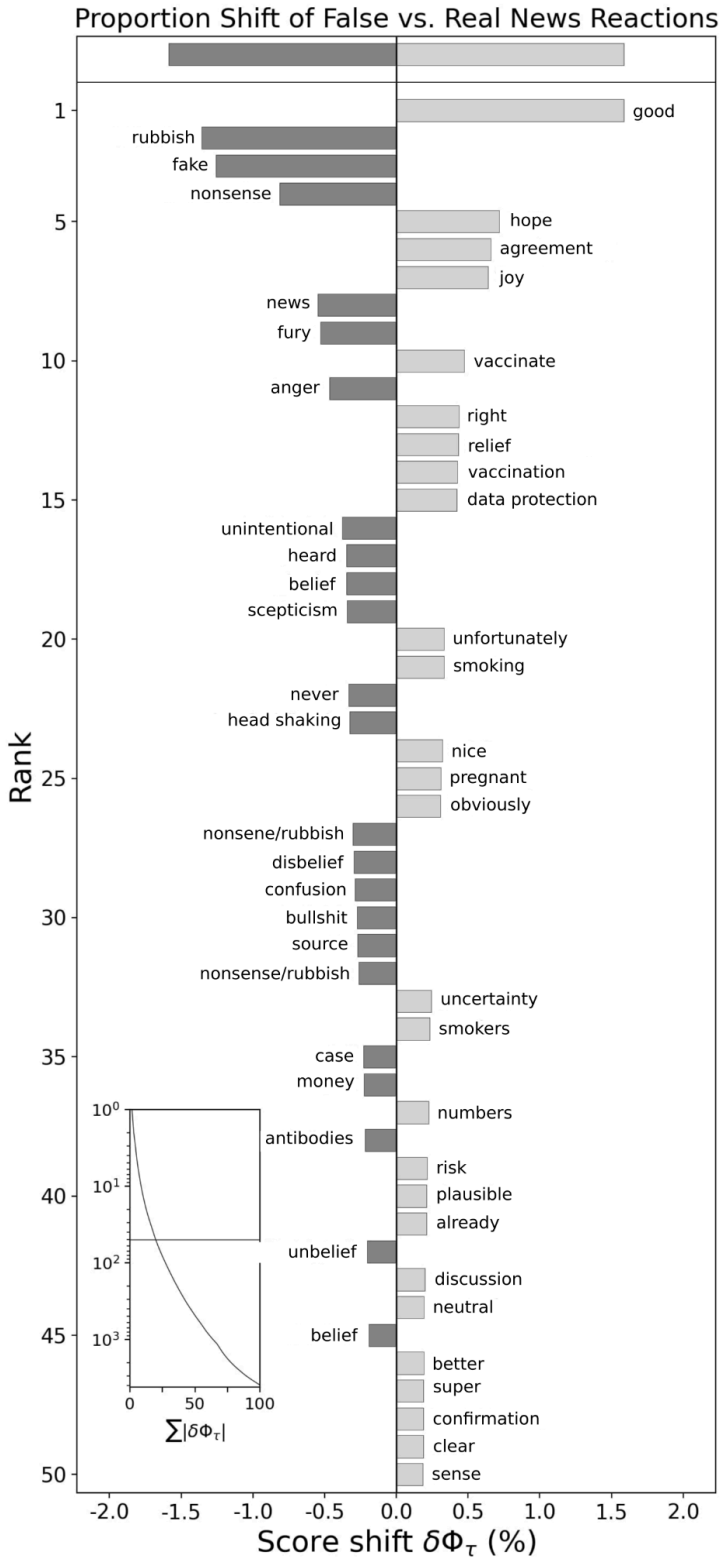


First Impulse or Thought Descriptions

Word frequencies in free-text descriptions of first thoughts also highlight a more angry response to false than real news items. Sentiment analysis with the 2015 German LIWC dictionary showed that out of 27,468 words, 527 words expressed an angry reaction to false news (3.71% of all reactions to false), whereas 141 words indicated an angry reaction to real news (1.06%). Figure 4 further compares the relative frequencies of words in the textual responses to false vs. real news and visualizes the difference in their proportions. Such word shift graphs show which words most strongly contribute to the differences between two texts

(Gallagher et al., 2021). Higher ranked words were more frequent after either false or real news, as also indicated by the score shift on the x-axis. Interestingly, the highest ranked words after false news included bullshit (Blödsinn), fake, bollocks/nonsense (Quatsch, Schwachsinn, Unsinn), skepticism (Skepsis), and disbelief (Unglaube), or shaking (my) head (Kopfschütteln), suggesting that many participants recognized the false news and expressed disbelief. Further, some of the highly ranked words expressed anger and irritation (Wut, Ärger, Kopfschütteln). Similar patterns can be observed in Figure S1 (absolute word frequencies) and S2 (word shift graph angry vs. non-angry responses). This suggests that a frequent reason for angry responses to false news was the recognition of such news as false.

Figure 4. Word shift graph showing differences in text responses describing thoughts and impulses after false compared to real news.

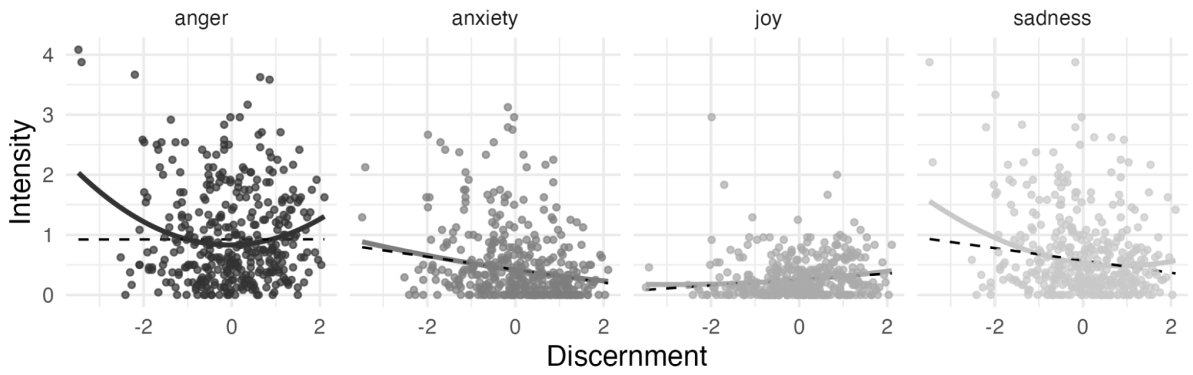


Note. Total $N = 27{,}468$ in words (5,613 texts). The left side (negative score) means words were more frequent after false news ($N = 14{,}224$), whereas words on the right side were more frequent after real news ($N = 13{,}244$). Words were translated from German. For original German words, see Figure S3.

Emotional Response and Discernment

The textual responses to false news indicated that some participants recognized false information and expressed their anger or disbelief. Rather than a linear relationship where stronger anger corresponds to a lower ability to recognize false headlines, this could hint at a non-linear relationship between discernment and emotional responses. Therefore, we first plotted graphs for the four rated emotions fitting both linear and curvilinear relationships (see Figure 5). Allowing for non-linearity is in line with a systems approach to emotions (Leach & Bou Zeineddine, 2021). The scatterplots show a linear positive relationship between anxiety and accuracy ratings for false items (b = 0.21, 95%CI[0.17, 0.24], $p < .001$, see Table S6/7 for detailed results), resulting in a negative relationship with discernment (b = -0.18, [-0.23, -0.13], $p < .001$). That is, a more anxious response was correlated to lower discernment abilities, i.e., when a false headline made people more anxious, they were more likely to rate it as accurate. Joy also showed a linear and positive relationship, but only for real news (b = 0.24,[0.20, 0.27], $p < .001$), and discernment (b = 0.20, [0.15, 0.26] $p < .001$; Tables S8-S9). In contrast, anger and sadness plots showed a weak curvilinear tendency, so we compared mixed-effects models with raw second-order polynomial terms to the linear mixed-effects model for anger (Table S10-S15) and sadness ratings (Tables S16 to S21).

Figure 5. Robust polynomial curves for news discernment and emotional responses.

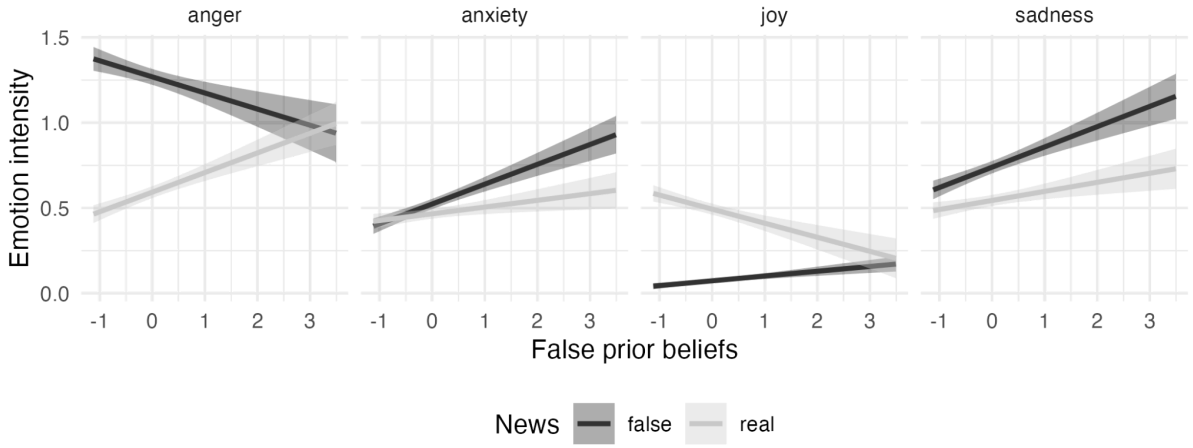


Note. Black dashed line represents the alternative (robust) linear model.

We evaluated model fit in two steps: First, we compared polynomial to linear model performance using a chi-square test for nested models, as well as marginal and conditional R^2s. Second, we assessed the robustness of the curves by excluding potential outliers. For anger, the polynomial model fitted better, $\chi^2(2) = 215.06$, $p < .001$, and the explained variance increased by 2% (marginal and conditional R^2/with and without random effects). This suggests that the polynomial model described the pattern shown in the scatterplot slightly better. In addition, outlier analysis did not reveal any influential cases (Cook's distance not greater than .05; see Table S14 and S15 for models excluding outliers). The first-order (b = -0.09, [-0.13, -0.05], $p < .001$) and the non-orthogonalized second-order term (b = 0.29, [0.25, 0.33], p < .001) indicate a positive (convex) quadratic curve for false items (a = -0.05, [-0.11, -0.02], $p < .001$), i.e., both lower and higher levels of discernment were related to higher anger, while moderate discernment abilities co-occured with lower anger scores. In other words, people who were especially good or bad at recognizing false news were more angry after exposure to the false news. For sadness, the polynomial model also seemed to describe

the data slightly better, $\chi^2(2) = 24.78$, $p < .001$, but the fixed effects for false items were very small, explaining less than 1% of variance more. Therefore, the simpler linear model seemed to fit better (for false items: b = 0.11, 95%CI[0.08, 0.15], $p < .001$; for real items: b = 0.08,[0.04, 0.11], $p < .001$; see Tables S16 and S18).

Figure 6. Emotional reaction intensity per news type in relation to prior false belief.



Emotional Responses and Agreement with False Beliefs about COVID-19

To understand how agreement with false beliefs about COVID-19 relates to emotional responses to false and real news items, we ran a linear mixed-effects model on each of the four emotional responses. Full results are reported in Table S22 and visualized in Figure 6. When exposed to real news items, participants with more false beliefs about COVID-19 reported more anger (b = 0.12, 95% CI [0.04, 0.19] $p < .001$) and less joy (b = -0.08, [-0.12, -0.05], $p < .001$) than participants with less false beliefs. Anxiety and sadness responses to real news were not significantly correlated with false beliefs (anxiety: b = 0.04, [-0.02, 0.10], $p = .190$; sadness: b = 0.05, [-0.01, 0.12], $p = .124$). In contrast, participants who held more false beliefs reported more anxiety (b = 0.12, [0.06, 0.17], $p < .001$) and sadness (b = 0.12, [0.05, 0.19], $p < .001$) after false news, as well as slightly lower angry responses (b = -0.09,

[-0.17, -0.02], p = .020). In brief, false beliefs about COVID-19 contributed to more angry and less happy responses to real news, and more anxious and sad responses to false news.

Discussion

To further the understanding of the role of emotions in misinformation processing, we conducted an online survey in Austria in December 2021. Specifically, we assessed the negative correlation between prior affective state and discernment between false and real news items about COVID-19. Our study conceptually followed a correlational study from Martel et al. (2020), which found that stronger emotions before misinformation exposure coincide with a lower performance in discerning false from real news. We extended this study in multiple ways: we distinguished prior affective state from direct emotional responses to news items; we included additional basic emotions and arousal, which are particularly relevant for misinformation processing; we used COVID-19-related instead of political misinformation; finally, we gave participants the opportunity to describe their first thoughts about news items. Below, we interpret our results focusing on the adaptive function of emotion in misinformation processing, and discuss how this perspective, as well as other factors, may explain why we did not replicate the findings of Martel et al. (2020).

In contrast to Martel et al.'s (2020) study 1, we could not confirm a correlation of affective state overall (H1) or positive (H2a) and (H2b) negative affective state separately, with misinformation discernment. Concretely, people were neither worse at discerning real from false news when they reported stronger emotions prior to exposure, nor did they agree more with common false beliefs about COVID-19 vaccines and other preventive behaviors. We pre-registered hypotheses based on prior literature, which suggested that emotions worsen misinformation discernment, with evidence seeming most robust for high-arousal emotions

(H3), including particularly anger (H4) and anxiety (H5). Yet, our analyses did not consistently support any of these pre-registered hypotheses for prior affective state.

Yet, planned exploratory analyses revealed that direct emotional responses to false and real news items differed, with higher anger for false and higher joy ratings for real news items. A simple explanation for higher joy responses after reading real news in our study is that half of the real items reported on the safety and benefits of vaccines, and in our sample, where only 4.5% of all participants said they did not intend to get vaccinated, it is plausible that these news items elicit positive emotions. In contrast, first thoughts after false news items more often contained words expressing anger, and other words like bullshit, nonsense, *rubbish, fake, skepticism,* or *disbelief.* These words reveal that most participants were not angry because they believed the false news stories but because they recognized them as false. In line with this, we observed a nonlinear relationship between angry responses and discernment: both people with high and low discernment abilities reported higher anger than people with average discernment. This indicates that anger arose for different reasons across participants with different prior beliefs: Some may have shown anger *because* of the misinformation, but most seem to have expressed their anger *about* the misinformation. Anger did not make people more susceptible to misinformation per se; rather, it seemed to depend on their interpretation, and thus, prior belief. Further exploratory analyses confirmed that participants who held more false beliefs about COVID-19 were more angry and less happy after real news, and less angry about false news, than the majority in our sample. Those with more false beliefs also reported being more anxious and sad after reading false news, which makes sense if they believed their content. That anger after false news in our study seems to mainly indicate recognition, and not acceptance, is consistent with a recent study in which participants with higher discernment abilities reported anger more often, but only for politically discordant headlines (Bago et al., 2022). Together with this, our results

suggest that factors like prior (political) beliefs may be crucial for understanding the association between emotion and perceived news accuracy.

Overall, our results suggest that emotions can have beneficial effects on misinformation discernment in some cases, rather than making people more gullible in general (Kaplan et al., 2016; Van Damme & Smets, 2014; Yeo & McKasy, 2021). Instead, they seem more compatible with the idea that emotions (usually) serve an adaptive function, based on the evolutionary theory of communication (see Mercier, 2021), rather than emotions hindering reasoning and analytic thinking in general (Holland et al., 2012; Martel et al., 2020). In some cases, emotions may reinforce prior beliefs, and make us more vulnerable to accepting inaccurate information that is congruent with our beliefs (Bago et al., 2020; Knobloch-Westerwick et al., 2020; Wischnewski & Krämer, 2021). Yet, when misinformation contradicts prior beliefs, an angry reaction may also help us recognize implausible claims. To understand this differential function of emotion, it is crucial to consider the specifics of the particular context, including the origin of the emotion (person or stimulus; Van Damme & Smets, 2014), and the reason for the emotion, which often depends on prior beliefs (Ecker et al., 2022). Here, the origin of an emotional experience provides useful hints: that we did not observe an effect of affective state on discernment, but an association with certain emotional responses, suggests that emotions elicited by the stimulus are more relevant.

The timing of emotions could also offer one possible explanation for the null results in our conceptual replication of Martel et al.'s (2020) study 1. We asked participants to rate their emotional experience over the past few days, whereas Martel et al. (2020) asked about emotions at the moment. We only noticed this difference after data collection. Nevertheless, we observed significant variance in emotions, and consider it likely that participants relied in part on their current affective state when trying to recall their emotions during the last days (Robinson & Clore, 2002; Van Boven et al., 2009). If one assumes that asking about a slightly

longer time period explains our null-result for affective state, this would still support the argument that the more temporally proximate an emotion is to misinformation exposure, the more relevant it is. In other words, immediate emotional responses are more relevant than current affective state, which is more relevant than affective state during the last days.

Another explanation for the contrast in results to Martel et al. (2020) might be found in our non-representative sample, which was recruited by psychology students, and therefore, was more left-leaning and highly educated. What an emotional response to false news means differs across individuals depending on their prior beliefs. Concerning news about COVID-19 in 2021 in Austria, people on the political right were generally opposed to COVID-19 measures and protective behaviors and thus, potentially more likely to fall for COVID-19 misinformation. Nevertheless, we observed considerable variance in news discernment and affective state even in our left-leaning sample. We should thus have been able to observe a correlation between discernment and emotions. Finally, factors like the country and topic difference could be raised as explanations, but do not seem plausible to us. First, COVID-19 news was as politically polarized in Austria as political news is in the US. Second, health is of great personal relevance to everyone, making it implausible to hypothesize a negative relationship between emotion and misinformation discernment only for political but not COVID-19-related ones.

Taken together, we find it unlikely that any of these differences between our and Martel et al.'s exploratory study 1 (2020) can fully account for the current null-result on affective state and misinformation discernment. Instead, we believe that this second pre-registered study should be weighted more strongly than the earlier exploratory one while still keeping the limitations of our study in mind. At the very least, the current study suggests that emotions do not generally hinder misinformation discernment but that people's prior belief, emotion in the content, and the timing of an emotion are crucial factors to consider. In

addition to the aforementioned limitations, it is crucial to emphasize that our study does not allow causal conclusions regarding the effect of emotion on misinformation processing. It only allows causal attribution of emotional responses to news items. Regarding more general limitations, the low levels of emotions and high discernment performances in online survey studies like ours (Bago et al., 2022; Martel et al., 2020) point to the compromised ecological validity of study designs based on forced exposure to news items.

Our results highlight that future misinformation studies on emotions should consider measuring immediate emotional responses to news exposure rather than general affective state, and assessing their reason for experiencing an emotion, especially their prior beliefs.

In conclusion, increased emotions are not generally associated with increased acceptance of misinformation. Rather, in line with the evolutionary theory of communication, this relationship depends on the function of a specific emotion for a particular person in a particular situation. Our study highlights two factors that can determine the function of emotion with regard to misinformation: the origin of the emotion (a general state at the moment vs. response to the information) and the person's prior beliefs, which crucially determine how they interpret the information. To capture such complex relationships, the measurement of emotions is crucial: While the affective state of a person may influence their motivation to seek out new information and their general openness to select relevant information, the immediate emotional reaction to misinformation is more indicative of the emotional processes that influence how participants respond to it. Understanding the emotional processes around belief and sharing of misinformation requires taking into account their function for an individual in a particular context – sometimes, veracity is central to reaching a certain goal, but at other times, it may simply come secondary.

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Data and Code Availability

All the stimuli, survey materials, participant data, analysis scripts, as well as the pre-registration, are available via this OSF repository: https://osf.io/tgzxr/?view_only=47702aa08f70412d996a2f6cbd237f4c.

Author contributions

Contributed to conception and design: H.M., C.K.

Contributed to acquisition of data: C.K.

Contributed to analysis and interpretation of data: J.L., A.S., H.M., D.G.

Drafted and/or revised the article: J.L., A.S., H.M., A.W.

Final approval of the version to be published: J.L., A.S., H.M.

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