Communicating Microplastic Health Risks: Humor as a Tool for Cognitive Engagement

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Abstract

In today's oversaturated media environment, important messages like public health risks often get lost in the noise. Microplastics represent a growing concern, and their intangibility can make it harder for the issue to resonate with audiences. This study explores humor as a tool to stand out amongst the overload and re-engage people to promote deeper reflection. It is the first study to combine humor and microplastics, offering an empirical investigation into how humor influences cognitive engagement. While past research suggests humor may enhance engagement, empirical evidence remains scattered. The study compares three comic formats: an informative, non-humorous comic (control), a humorous comic using ironic exaggeration (one-sided), and a humorous comic presenting opposing views (two-sided). It examines how these formats effect emotional responses and more thoughtful reflection on the issue of microplastics. It also tests whether prior concern for microplastics predicts engagement, and whether emotions help explain this. An online survey with 205 participants shows that both humorous comics significantly increase engagement, regardless of prior involvement. Only negatively valenced emotions, and especially those with high perceived control like Disgust, explain this effect. These findings suggest amusement and serious reflection can coexist, and that humor, when emotionally targeted and issue-relevant, can support deeper thinking about complex problems like microplastics.

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Introduction

In today's digital age, where people are constantly exposed to an overload of information, potent communication has never been more crucial. Being continuously bombarded with advertisements, news, and persuasive campaigns makes it increasingly difficult for any single message to truly stand out and have an impact. This is especially true for public messaging on health and environmental issues, which frequently rely on alarming statistics and urgent warnings (Strothe & Fazal, 2011). While well-intentioned, such messages risk triggering issue-fatigue – a growing phenomenon where repeated exposure to the same types of messages leads to emotional exhaustion, reduced attention, and disengagement (Gurr & Metag, 2023). Rather than motivating action, audiences can become overwhelmed by the constant stream of problems competing for their concern, withdrawing altogether.

This effect of issue-fatigue is further compounded by audiences' preference for fast-paced, highly visual, and easily digestible content (Marathe & Kanage, 2024), which– despite being designed to attract attention– can ultimately result in numbness or apathy (So et al., 2017). Repeated messaging, once thought to increase acceptance through familiarity (mere exposure effect*,* Zajonc, 1968), can backfire when overused, leading to annoyance, boredom, and the loss of perceived novelty (Berlyne, 1970; Downs, 1972; Roseman, 1984). At the same time, people often avoid effortful cognitive processing unless strongly motivated– tending instead toward the path of least mental effort (least effort principle, Chaiken, Liberman, & Eagly, 1989). However, this attitude changes when uncertainty or ambiguity about a situation is high. For example when risks are not fully understood people are more likely to seek information out of an intrinsic need to reduce that uncertainty (risk aversion, McCombs & Weaver, 1973). Supporting this drive by allowing individuals to explore issues on their own terms, rather than being

imposed or coerced to, can enhance their sense of control. This in turn strengthens behavioral intentions and personal investment in the topic (Theory of Planned Behaviour, Ajzen, 1985). For communication to remain effective under the competitive conditions, especially on topics that lack immediate gratification or interest, new strategies are needed to ensure pressing issues still resonate with audiences. Preferably, these strategies are those that do not pressure, coerce or exhaust, but instead invite curiosity and reflection from within.

One promising way to counteract this fatigue and re-engage audiences is through humor. It encourages audiences to detect incongruity and interpret underlying meanings, requiring active cognitive processing in an inviting manner (Suls, 1983). Simultaneously, it preserves the audience's autonomy by prompting reflection rather than imposing it. This combination, demanding engagement while supporting self-directed interpretation, positions humor as a particularly effective and non-coercive persuasive tool in an oversaturated media environment. Empirical research supports this: a recent study by Skurka and Cunningham (2023) found that humor in climate messaging can reduce psychological resistance and help make polarizing topics feel more approachable. Similarly, humor has proven effective in health campaigns addressing smoking, sexual health, and vaccination hesitancy, seemingly lowering defensiveness and increasing message receptivity (Brigaud et al., 2021; Blanc & Brigaud, 2014; Moyer-Gusé et al., 2018; Ort & Fahr, 2020).

Nevertheless despite humor's communicative potential, one particularly relevant health issue has yet to be explored: microplastics– with no studies till date examining the potential of humor to effectively engage audiences on the topic. Microplastics represent a growing concern due to their widespread presence in the environment but also their potential health consequences when these microscopic particles enter the human body (Machado et al., 2018; Mahu et al.,

2023). Microplastics have infiltrated nearly every part of the planet, with detections in Arctic ice, deep-sea sediments, and soil (Catarino et al., 2021). They have been detected in food, synthetic clothing and even the air we breathe, making human exposure to microplastics inevitable (De-la-Torre, 2020). The issue of microplastics is particularly concerning due to its invisibility. Unlike more tangible environmental or health threats, the direct consequences of microplastic exposure go unnoticed in daily life. Furthermore, the repercussions of these on the human body remain poorly understood, a situation exacerbated by the limited availability of rigorous data which contributes to the public perceiving the issue as less urgent (Blackburn & Green, 2021; Felipe-Rodriguez et al., 2022; Wright & Kelly, 2017).

To better understand how humor can support public awareness of microplastics, this study aims to compare how, firstly, different types of humor influence the extent to which people think about the issue. It focuses on two styles of humor: one that presents a single exaggerated or ironic point of view (one-sided humor), and another that presents two opposing perspectives (two-sided humor). Both are compared to a non-humorous comic to assess which approach encourages people to reflect more deeply on the health risks associated with microplastics. Secondly, the study examines whether people's prior concern about microplastics affects how engaged they become with the message they see. Finally, it investigates how emotional reactions elicited by the comics explain why certain types of messages prompt more thoughtful consideration than others. This exploratory study contributes to broader questions about how emerging or invisible risks can be communicated in ways that break through issue-fatigue and stimulate meaningful public engagement.

Literature Review

Humor as a Tool for Cognitive Engagement and Social Critique

Humor is a universal human phenomenon found across all cultures, though its perceived effectiveness is shaped by cultural norms, linguistic conventions, and contextual knowledge (Martin, 2007). Broadly defined, humor is a communicative act designed to provoke amusement, typically manifested through laughter or smiles, by leveraging incongruity and surprise (Martin, 2007). Humor serves social, psychological, and communicative functions, albeit its effectiveness relies on the audience's ability to identify and interpret these incongruities. Humor often arises from the unexpected juxtaposition of ideas (e.g., in sarcasm and irony) or situations that create tension followed by emotional release– occurring when a perceived threat or incongruity (e.g., disruption of normative expectations) is simultaneously framed as harmless or acceptable (benign-violation theory, McGraw & Warren, 2010; Gervais & Wilson, 2005)

One of humor's distinctive strengths is its ability to highlight contradictions, ironies, or hypocrisies within society, making heavy or complex topics more approachable. It offers a way to present unsettling or absurd truths– like the presence of microplastics in our food, water, and even our bodies– without immediately triggering defensiveness or hopelessness in the audience. Rather than framing such realities as catastrophic, humor offers audiences a means to process and laugh at the absurdities of modern life with emotional distance and light-heartedness (Sliter et al., 2013; Celso et al., 2003). This not only reduces the psychological barrier to these topics, but also invites more open dialogue around taboo or uncomfortable subjects (Moyer-Gusé et al., 2011; Nabi, 2016). Furthermore, humor as a coping strategy can contribute to overall improved well-being by facilitating a positive reframing of threats (Celso et al., 2003).

Through embedding critique within comedy, humor can challenge dominant norms and highlight flaws in systems that have come to be perceived as "normal," thereby making complex issues more digestible. It gently nudges the audience to consider whether we have unknowingly normalized the presence of microplastics in our food and bodies. This incongruity between what audiences expect and what they accept becomes the punchline, prompting reflection by highlighting the absurdity of the situation. In some cases, these contradictions may trigger cognitive dissonance. Presenting an unexpected perspective can be a powerful way to raise awareness and encourage deeper cognitive engagement with the issue at hand. When factual messages fail to resonate or capture attention, humor may act as a catalyst to re-evaluate behaviours that previously seemed uninteresting or irrelevant. This process can subconsciously motivate individuals to invest more cognitive effort and align their actions and with their values (e.g., *"I care about not ingesting microplastics"*).

The Effectiveness of Humor: Contexts, Audience Involvement, and Persuasive Outcomes

Previous studies on the effects of humor for awareness-raising and behaviour change have been done in the contexts of advertising, political discourse, health campaigns, and more recently climate change (Strick & Dijksterhuis, 2017; Eisend, 2009; Nabi, 2016; Becke & Anderson, 2019). Although humor's effectiveness depends highly on the context and individual's prior involvement with the topic, this study anticipates that humor can be effective in raising awareness about microplastics.

In humor studies, involvement-level is often considered an influential factor that can shape message effectiveness. For example, in commercial advertisements, humor has been found to be more persuasive in low-involvement contexts than in high-involvement contexts (Zhang &

Zinkhan, 2006). The same was found for political discourse, where humor only had persuasive power for low-involvement topics (Strick & Dijksterhuis, 2017). In contrast to findings from political contexts and advertising, several studies in health and environmental communication demonstrate that humor can also be effective in high-involvement contexts.

Previous studies have compared humorous and non-humorous preventive health advertisements for topics such as tobacco, alcohol, obesity, and sexual health awareness (Blanc & Brigaud, 2014; Brigaud et al., 2021; Ort & Fahr, 2020). These studies consistently showed that the presence of humor attracted greater attention and promoted participant memory retention. Research using eye-tracking methods found that humorous health messages not only attracted more attention but also promoted more elaborate information processing compared to non-humorous messages, suggesting that humor can enhance cognitive engagement regardless of prior involvement (Blanc & Briguad, 2014). Moreover, humor can help reduce defensive reactions and message resistance, particularly among low-involvement audiences such as vaccine-hesitant parents (Moyer-Gusé et al., 2018).

By lowering psychological reactance and increasing openness, humor allows sensitive topics to be approached in a more disarming way, creating more receptive audiences among those who might otherwise disengage. Since microplastics is an emerging issue with generally low public involvement, this study explores humor as a potential strategy to capture attention and foster initial engagement with the topic.

Conceptualizing One-Sided and Two-Sided Humor in Message Processing

Within literature, humor is recognized as a persuasive tool that can influence how messages are processed and received (Becker & Anderson, 2019). Among various humor types

and categorizations, two types of humor are commonly studied: one-sided humor and two-sided humor. While definitions vary across studies, this thesis adopts a conceptual distinction based on perspective-taking.

One-sided humor presents a singular, often highly ironic or exaggerated viewpoint highlighting the absurdity of a situation from one perspective. This tends to work well when the target audience already agrees with the underlying messages, as it reinforces existing beliefs and evokes strong emotional responses (Becker & Anderson, 2019). For individuals who are already engaged with the issue, the humor aligns with their perspective and is easily interpreted.

In contrast, two-sided humor introduces a total of at least two opposing perspectives, often through juxtaposing exaggerated arguments from both sides. This study specifically focuses on refutational two-sided humor, which refers to messages that not only present a counter argument but also refute it. Among the two types of two-sided messages, refutational and non-refutational, only the former has been shown to be more persuasive (Allen, 1991). This approach tends to be more effective and accessible to audiences less invested in the topic. By playfully presenting conflicting viewpoints, refutational two-sided humor facilitates the audience's understanding by explicitly highlighting contradictions, thereby making the underlying absurdity easier to grasp (Eisend, 2022). Throughout this thesis, the term "two-sided humor" will therefore refer specifically to refutational two-sided humor.

In the broader context of message framing, Mike Allen's (1991) meta-analysis on one-sided versus two-sided messages found that refutational two-sided messages were more generally persuasive, while non-refutational two-sided messages were less persuasive. Conversely, one-sided messages were generally perceived as more favorable and entertaining than both refutational and non-refutational two-sided messages (Allen, 1991). These findings

support the idea that presenting and then refuting opposing viewpoints can make messages appear more fair and transparent (discounting hypothesis, Allen, 1991). This allows audiences to engage more critically, weigh both sides, and feel they can make up their own minds, enhancing overall message persuasiveness.

Cognitive Engagement and the Elaboration Likelihood Model (ELM)

Persuasion is defined as the process by which attitude change is brought about (Colman, 2015). In the context of public communication, understanding how and when audiences are persuaded to care or think more deeply about issues is essential. One of the most well-known and influential models of persuasion is the elaboration likelihood model (ELM) (Petty et al., 1986), which outlines two main routes of message processing: central and peripheral. These routes are distinguished by the degree of cognitive elaboration, which is: the extent to which an individual actively reflects on a message and links it to existing knowledge, attitudes, or beliefs. The central route involves high elaboration, leading to deeper, more effortful processing and more durable attitude change. In contrast, the peripheral route is characterized by low cognitive elaboration, relying on superficial cues and shallow, descriptive processing. The route an individual takes depends largely on their motivation to use cognitive resources to process the message, with involvement level playing a large role in determining which route is followed and to what extent.

This study does not directly test the ELM, but uses it as an interpretive framework to understand routes of message processing. This lens helps assess how different emotional and humorous content influences the depth of individuals' engagement with the issue of microplastics.

Connecting Cognitive Elaboration, Involvement Level and Humor

The ELM suggests that an individual's involvement level with a topic typically predicts the depth of message processing (Petty, Richard & Cacioppo, 1986). This is the result of perceived consequence.

In low-involvement contexts, individuals are less motivated to expend cognitive effort because the potential consequences of making an inaccurate judgment are minimal. Conversely, in high-involvement contexts, where the outcomes of forming an incorrect judgment are personally significant, people are more likely to engage in deeper processing of the message (Strick, 2021).

Humor, however, complicates this relationship. According to preliminary evidence, humor tends to reduce the depth of processing by eliciting a positive mood that creates a sense of certainty and comfort (Schwarz, 1990; Tiedens & Linton, 2001). This can therefore distract individuals from the message and decrease the extent to which people engage with the underlying content. Additionally, the effect of humor could be problematic since peripheral persuasion is superficial and not grounded in substantive reasoning. This initial evidence suggests that humor may therefore encourage more shallow processing, rather than urging audiences to reflect on the message at a deeper level (Moyer-Gusé et al., 2011). However, research by Cline and Kellaris (2007) suggests that this effect can be reversed when the humor is closely tied to the issue itself– also known as related humor– as this helps readers stay engaged with the underlying message despite the positive tone.

More recent studies contradict earlier assumptions of humor primarily encouraging peripheral route processing, noting that the effectiveness of humor depends on the specific context and message type. For instance, research on humor in pro-environmental communication

found that humor can enhance cognitive engagement with environmental risks, even among low-involvement individuals (Skurka & Cunningham, 2023). Moreover, humor had positive effects in persuasive messages about the importance of a healthy lifestyle (Blanc & Briaud, 2014), the benefits of vaccination (Moyer-Gusé et al., 2018), and the consequences of risky sexual behaviours (Futerfas & Nan, 2017).

To better understand how humor might facilitate or hinder deeper engagement depending on involvement level, this study explores its role in message processing about microplastics, addressing contradictions and gaps in the current literature.

The Role of Emotions and Ambivalence

While humor type is the independent variable in this study, emotional responses elicited by the comics may play a crucial role in shaping to the extent to which individuals cognitively engage with the issue of microplastics. Comics are particularly effective at eliciting emotions because they combine visual and textual storytelling in a concise, engaging format, often using humor, irony, and relatable scenarios to connect with audiences with the underlying message (Sabri et al., 2024). This emotional engagement is important, as preliminary evidence suggests that emotions differ in their impact on motivation to cognitively reflect (Bower, 1983). How these emotions influence cognitive elaboration is still unclear, as the effects are often highly malleable and context-dependent (Clore et al., 2017). However, a few theories do exist on how similarly grouped emotions may impact cognitive engagement.

Firstly, one general finding suggests that negatively valenced emotions (e.g., fear, guilt or sadness) can promote more careful information processing, while positive emotions (e.g., joy or amusement) discourage effortful thinking (Mackie & Worth, 2020). This occurs because positive

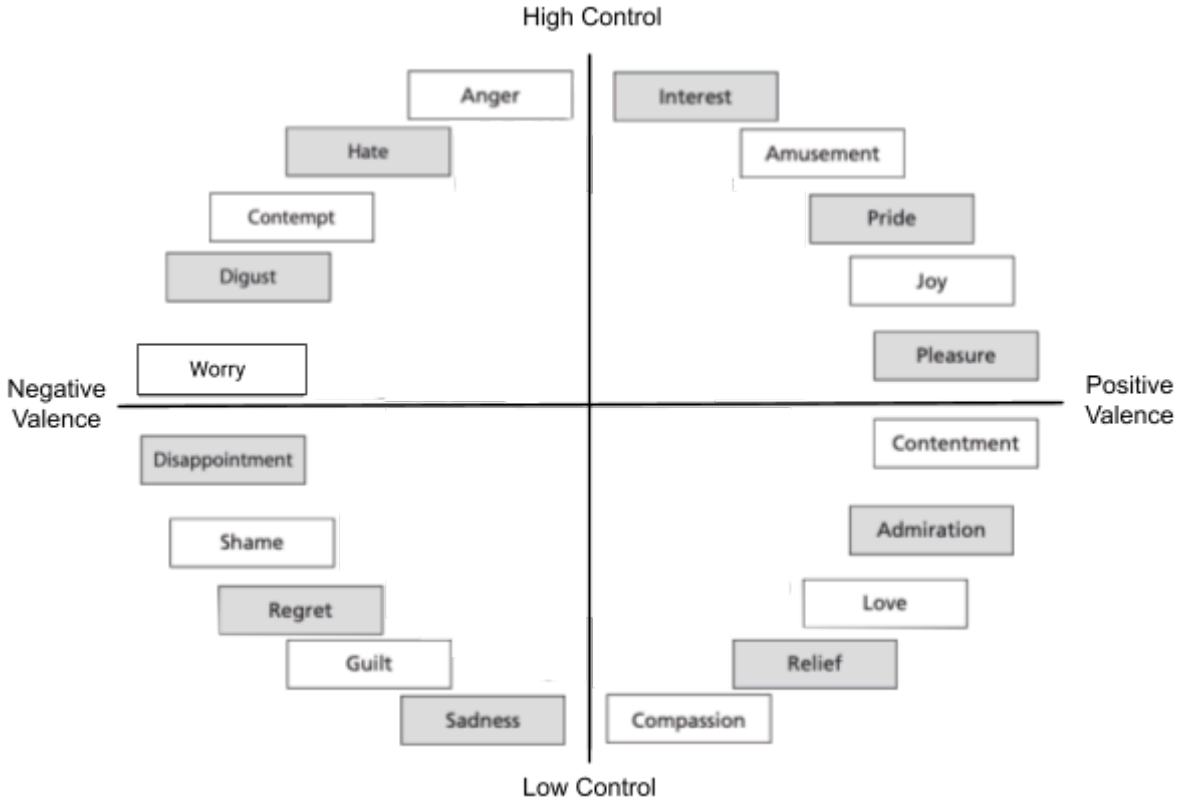
emotions– even when the topic is serious or urgent– signal a sense of safety and well-being, which reduces the perceived need for careful or critical thinking. In other words, feeling positive acts as a cue that the situation is not threatening, leading people to engage less deeply with the issue (Schwarz, 1990).

Additional preliminary research argues that it is not valence alone that explains how emotions influence engagement, but rather that it depends on the level of control associated with the emotional experience (Dubovi & Tabak, 2021). This refers not to control over the emotion itself, but rather the perceived degree of control individuals feel they have over the situation that elicited the emotion. Emotions associated with high control (such as anger or disgust) may lead individuals to feel empowered and capable of taking action, potentially encouraging deeper reflection and greater cognitive effort (Sacharin, Schlegel, & Scherer, 2012). In contrast, low-control emotions (such as sadness or guilt) may evoke a sense of helplessness or withdrawal, potentially reducing the likelihood of elaborative thinking.

To interpret the role of emotions in this study, the Geneva Emotion Wheel (GEW) 3.0 will be used as a framework (see Figure 1). This model categorizes 20 emotions along two dimensions: valence (positive-negative) and perceived control (low-high) (Scherer et al., 2013). The GEW allows for a structured, theory-informed mapping of emotion responses, offering insight into how different emotional profiles might shape patterns of cognitive engagement. The GEW itself is not a theory of emotional impact, but serves as a useful tool for organizing and interpreting the emotions reported in response to the different message types.

Figure 1

Geneva Emotion Wheel (Version 3.0)



Note. Diagram adapted from Scherer et al., (2013).

Beyond the GEW model, another relevant and distinct consideration is the level of emotional certainty or ambivalence, which may influence the depth of message processing (Smith & Ellsworth, 1985; Linton, 2001). This perspective differentiates between certain and uncertain emotions (Appraisal Theory; Smith & Ellsworth, 1985). While emotional certainty reflects the clarity of an emotional experience and its cause (e.g., “Microplastics are harmful and I’m sure of it”), the dimension of control refers to how much influence an individual feels they have over the situation evoking the emotion (e.g., “Microplastics are harmful, but I can do something about it”).

Preliminary evidence suggests contradictory effects of certain versus uncertain emotions. Schwarz (1990) argues that certain emotions, such as anger, disgust or joy, may lead to quicker, more heuristic processing, thereby reducing cognitive effort. This is because certain emotions are typically accompanied by a clear sense of what caused the emotion and a confident evaluation of the situation. These emotions are often intuitive and confident leading to a reduced need for effortful processing while uncertain emotions such as hope, worry, or curiosity, often trigger more reflective processing (Strick, 2021). This is due to ambiguity or a lack of clarity about the situation therefore putting individuals in an uncomfortable state. This uncertainty motivates people to seek out additional information to reassure themselves, therefore reflecting more deeply on the message. However, Tiedens and Linton (2001) argue that certainty in emotion does not necessarily reduce cognitive effort. Instead, they propose that some certain emotions can also stimulate systematic processing, particularly when the emotion conveys personal relevance or importance.

While humor can evoke a wide range of emotions, their impact on deeper message processing remains unclear in literature. Preliminary research suggests that emotional ambivalence may enhance elaboration (Strick, 2021), but systematic evidence is lacking and inconsistent. This study offers a novel contribution by quantitatively exploring which emotions are most associated with cognitive engagement. By mapping emotional responses according to the third version of the GEW, it bridges humor research with health communication, advancing our understanding of how emotions shape message effectiveness.

Current Study

In sum, the literature presents a complex and nuanced picture. Researchers can generally agree that humorous messages consistently attract greater attention, increase perceived relevance and improve memory retention compared to non-humorous content (Skurka & Cunningham, 2023; Skalski et al., 2009). Additionally, humor plays a unique role in reducing discomfort around taboo or unfamiliar topics, making them more accessible, lighthearted and less shame-inducing for audiences. Despite humor having previously been thought to trigger shallow (peripheral) processing, recent studies have proven otherwise. According to Becker & Anderson (2019), under the right conditions, humor may even facilitate deeper engagement, especially when message design, humor type and audience involvement align. Emotional responses matter not only because they reflect audience reactions, but also because affect serves as an internal cue– signaling whether a message is worth further cognitive effort.

For emerging issues like microplastic pollution, where scientific uncertainty and low public familiarity may hinder engagement, understanding how all these topics interact is essential. As public awareness of microplastic health risks are still in its early stages, this research seeks to anticipate future communication needs by exploring humor as a proactive and emotionally resonant strategy for raising awareness. It offers insights into how audiences might be pushed to cognitively engage with the issue before it reaches a critical tipping point.

To explore this, the study adopts an exploratory, between-subject design to investigate how different types of humorous messages influence cognitive elaboration on the issue of microplastics. Interpreted through the ELM framework and GEW (3.0), the research explains whether different humorous framings impact participant's emotional responses and motivation to engage with the message. Through an online qualtrics survey, participants were randomly

assigned to one of three conditions: a control (non-humorous) comic, a one-sided humorous comic (presenting only one perspective), or a two-sided humorous comic (presenting both a claim and a counterargument). This approach allows for a clear investigation of how humor types interact with emotional responses and involvement levels, addressing an empirical gap in understanding their combined effect on engagement with the issue of microplastics.

Methodology

Participants and Recruitment

A power analysis conducted prior to data collection determined that a minimum of 160 participants was needed to detect a medium effect size with an alpha level of 0.05. A total of 205 responses were collected, of which 190 were deemed complete and suitable for analysis. In total 122 females (59.5%) and 73 males (35.6%) participated in the study, 10 of which identified as non-binary or as a gender other than male or female (4.9%). Age ranged from 18 to 76 (M = 28.3, SD = 13.4). Approximately 63% (n = 130) of the respondents were students, with 31% (n = 65) working part-time or full-time jobs. The remainder of participants were either unemployed, retired or stay-at-home parents (n = 11). Respondents represented 38 different countries, with the majority being from The Netherlands and Germany. Furthermore, 54% of participants identified as omnivores with no dietary restrictions, 24% as flexitarians, and 15% as either vegetarians or vegans (see Appendix A for a complete breakdown of participant demographics).

Participants were recruited using convenience and snowball sampling, mainly through social media platforms such as Instagram, LinkedIn, and Whatsapp communities. Additional outreach was conducted via international networks and university-related contacts. These networks acted as catalysts for the survey to gain traction and participants from various communities. Any individuals aged 18 and above were eligible to participate. The goal was not to target a specific demographic, but rather to gain a broad range of responses for this exploratory study. Efforts were made to include diverse networks, especially from varying age groups, backgrounds, and occupations. All participants gave informed consent before beginning the study. Proficiency of English was necessary for the completion of the survey, with no translations available for other languages. Participants were randomly assigned to one of three

conditions (comics) using an automated function in the survey platform. Participants were unaware of this randomization to reduce bias in their responses.

Procedure

Prior to data collection, a pre-test was conducted with seven participants to evaluate both the survey questions and the comic stimuli. Participants were asked to provide feedback on the clarity of the questions and the readability and interpretation of the comics. Their feedback led to improvements in question wording, clearer instructions for the open-ended items, and refinements in characters' facial expressions to better convey the intended tone of each comic.

All ethical procedures were reviewed and approved by the Campus Fryslân Ethics Committee. Participants provided informed consent before beginning the study, ensuring their voluntary participation and understanding the research purpose.

Participants were invited to complete the online survey over a two-week period. The survey was hosted on the University's Qualtrics platform, ensuring secure data collection and random assignment of participants to one of the experimental conditions. To optimize the survey viewing experience, participants were encouraged to complete the survey on a device with a larger screen, such as a computer, laptop or tablet.

After consenting, participants first completed Likert-scale questions that assessed their prior involvement with the issue of microplastics. They were then randomly assigned to view one of three experimental conditions: the control comic, the one-sided humorous comic, or the two-sided humorous comic. Randomization was automated to ensure approximately equal group sizes.

Following exposure to their assigned comic, participants completed an emotion intensity checklist adapted from the Geneva Emotion Wheel 3.0, to capture their immediate emotional reactions to the comic (Scherer, 2013). Next, participants responded to an open-ended question designed to assess their cognitive engagement with the topic of microplastics. Additional questions explored general attitudes related to fish consumption and people's current diets. Demographic information was collected at the end of the survey, along with questions assessing how likely participants were to pay attention to the comic and whether they would consider sharing it with others (e.g., friend and family).

At the end of the survey, participants received a full debrief explaining the true purpose of the study. While the initial description referred broadly to exploring people's perceptions on a comic, this framing was intentionally general to avoid priming or biasing participants' responses. The debrief also acknowledged that the topic of microplastics may evoke concern and also offered resources for participants interested in reducing plastic exposure in their daily lives.

Materials

Three custom-designed comics were created for the experimental conditions. Comics were deliberately chosen as the medium for delivering the humorous messages due to their popularity in comedic communication and their accessibility for English-speaking participants. As a format that combines visual art and textual narrative, comics are effective for presenting complex ideas in an understandable and engaging way (The University of British Columbia, 2024). This format also allowed for clear experimental control, making it easier to isolate the effects of different humor types on cognitive engagement. To ensure that differences in cognitive engagement could be attributed to the humor type rather than the storyline, the narrative setting

and characters were kept consistent across all comics. In each comic, a woman is seated at a restaurant and is served a fish dish by a waiter. At the top of each comic panel, a descriptive caption states: "*microplastics in our food*". This ensured audiences understood that the colorful fragments on the fish were microplastics and not The microplastic covered fish is illustrated in a colorful way **a**imed to portray how plastic fragments look if they were visible. This illustration stayed the same in all conditions to symbolize microplastic contamination, ensuring visual clarity of the message.

In the one-sided humor condition, the waiter smilingly presents the dish while saying "*Here you go madame, our finest fish with a hint of microplastics!*". The comic employs irony, as the woman appears delighted and eager to eat the contaminated meal, with exaggerated heart-shaped eyes emphasizing the absurdity of the situation. In the two-sided comic, the waiter's expression and dialogue remains the same, but the woman's expression changes to one of visible concern and distress. Thereby, displaying two opposing perspectives on the situation by changing her facial expression to concern and shock as a counterargument. In the control comic, no humor was implicitly used. The waiter neutrally states *"Here is your meal"*, and both characters appear expressionless.

Figures 2, 3 and 4 outline the key visual and textual elements that differentiate the three comics. No assumptions are made regarding the emotional or cognitive responses the comics may elicit; these were measured empirically during the study.

Figure 2

One-sided Humorous Comic

Note. All comics illustrated by student artist A. Thömmes

Figure 3

Two-sided Humorous Comic

Figure 4

Non-humorous Control Comic

Measures

Several variables were used to assess participant's response to the experimental comics and their engagement with the issue of microplastics. Two of the variables, *Engagement_Score* and *Involvement_Level_Score*, were self-constructed based on specific scoring criteria. All pre-existing and newly created variables are outlined in-depth below.

Condition

Participants were randomly assigned to one of three experimental conditions, each representing a different comic type: a one-sided humorous comic, a two-sided humorous comic, or a control (non-humorous) comic (see Figures 2, 3, and 4). This independent variable captures the message framing strategy employed in each stimulus.

Engagement_Score

Cognitive engagement was measured using an open-ended elaboration task, inspired by Coulter's (2004) message elaboration scoring method (M = 3.56, SD = 1.23) (see Appendix B Table B1). After viewing the assigned comic, participants were asked to write down any thoughts that came to mind. Participants were presented with six response boxes and instructed to write one complete sentence per box for any thoughts that came to mind. They were informed that it was entirely acceptable to leave boxes blank if they had fewer thoughts. Participants who did not answer this item were excluded from the analysis.

Cognitive engagement was operationalized through a message elaboration scoring criteria. A 5-point scale evaluated the depth and quality of the participants most elaborate response (see Table 1). Higher scores indicated more thoughtful, reflective, or interpretive elaboration with the issue of microplastics. In cases of uncertainty regarding the appropriate elaboration level, a second coder was consulted, and discrepancies were resolved through discussion.

Table 1

Construction of Engagement_Score

Score	Elaboration Level	Criteria	Example
1	Very shallow elaboration	Perceptual/surface comment. Purely descriptive; no interpretation.	"The fish looks colorful"
2	Slight elaboration	Simple evaluation/observation or emotional reaction. Basic	"This is gross"

		emotion or judgment.	
3	Moderate elaboration	Topic awareness. Issue acknowledged, vaguely stated.	“Plastic is in our food and environment”.
4	Deep elaboration	Personal relevance or consequence awareness. Issue linked to self or others.	“I never thought about how plastic in fish might affect my health.”
5	Very deep elaboration	Reflective reasoning or problem-solving thought. Includes reflection, cause-effect, or action.	“I worry about how many microplastics I’ve already consumed through eating seafood. It makes me question how safe it is and why governments don’t do more to regulate this.”

Note. Adapted from Coulter (2004).

Involvement_Level_Score

The Involvement_Level_Score was measured by summing the responses of two Likert Scale items that measured participants' concern for microplastic pollution and their effects on (1) the environment, and (2) their personal health or well-being. Responses were recorded on a 7-point scale (1 = not concerned at all; 7 = extremely concerned) and summed to create the Involvement_Level_Score (range: 2–14). Higher scores reflected greater perceived concern and prior involvement with microplastics. The scale demonstrated good internal consistency (Cronbach’s $\alpha = 0.82$; $M = 10.40$, $SD = 2.69$), indicating reliable measurement of the involvement construct (see Appendix B Table B2).

Diet

Diet was categorized into one of six groups: vegetarian, vegan, omnivore, flexitarian, carnitarian, or other. While not a central variable of interest, this measure was included to assess whether participants who do not consume fish responded differently to the comics– given that the scenarios referenced fish consumption– and to determine whether their responses remained relevant for inclusion in the broader analysis.

Emotions

The emotional responses measured matched the 20 discrete emotions listed in the GEW 3.0. Participants indicated the intensity of which they felt each emotion after viewing the comic using a visual scale of variable-sized bubbles. The larger the bubble, the more intensely participants felt the emotion. These intensities were converted into numerical values ranging from 1 (not felt at all) to 6 (felt very strongly), enabling the emotional responses to be analyzed quantitatively.

The emotions included in the GEW 3.0 and used in this study are as follows: Interest (M = 3.82, SD = 1.21), Amusement (M = 3.20, SD = 1.45), Pride (M = 1.38, SD = 0.79), Joy (M = 1.64, SD = 0.96), Pleasure (M = 1.65, SD = 0.98), Contentment (M = 1.45, SD = 0.81), Love (M = 1.21, SD = 0.58), Admiration (M = 1.44, SD = 0.79), Relief (M = 1.27, SD = 0.69), Compassion (M = 2.04, SD = 1.27), Sadness (M = 3.78, SD = 1.51), Guilt (M = 3.04, SD = 1.65), Regret (M = 2.61, SD = 1.56), Shame (M = 2.90, SD = 1.66), Disappointment (M = 3.79, SD = 1.71), Worry (M = 4.20, SD = 1.55), Disgust (M = 3.44, SD = 1.66), Contempt (M = 1.87, SD = 1.30), Hate (M = 2.06, SD = 1.40), and Anger (M = 2.81, SD = 1.52) (see Appendix B Table B3).

Data Analysis

To investigate the effects of different comic types on participants' responses, a series of statistical analyses were conducted in R. Given the sample size (N = 205), parametric tests were considered appropriate due to their robustness to violations of normality. The primary objective was to assess whether the different comic conditions, one-sided humor, two-sided humor, or non-humorous (control), led to varying levels of cognitive engagement with the issue of microplastics. In addition, the analysis explored whether participants' level of prior involvement with the topic influenced their degree of cognitive engagement. Lastly, the analysis compared emotional responses across the different formats and explored whether, and if so which, specific emotions were associated with increased cognitive engagement.

The main analysis followed a structured sequence to address these aims. A one-way ANOVA assessed the impact of each comic type (one-sided humor, two-sided humor, and control) on cognitive engagement, followed by Tukey post-hoc tests to identify and compare specific group differences.

Next, to ensure validity of the main analysis, a preliminary check was conducted to examine whether participants' dietary habits influenced cognitive engagement across the comic conditions. Specifically, since the comics depicted a restaurant scenario involving fish consumption, this check assessed whether fish-eaters and fish-avoiding individuals differed in their cognitive engagement response to the comic condition. Using a one-way ANOVA and Tukey post-hoc tests within each dietary subgroup, this analysis aimed to determine if dietary habits moderated the effect of comic condition on engagement and whether non-fish eaters should be included or excluded from the main analysis.

A linear model evaluated the influence of participants prior involvement with microplastics on cognitive engagement and whether this relationship varied across comic conditions, testing both main and interaction effects simultaneously. This was, evaluating whether comic conditions were more effective for varied involvement-levels on engagement.

Causal pairwise mediation analyses were conducted to examine whether specific emotional responses mediated the effect of comic condition on cognitive engagement. For each pairwise comparison (one-sided vs. control, two-sided vs. control, and one-sided vs. two-sided), separate linear regression models were used to estimate the mediator (emotion) and outcome (engagement). Using the R mediation package with 1,000 bootstrapped simulations, the analyses estimated the average causal mediation effect (ACME), average direct effect (ADE), and total effect. Only cases with complete data on all variables were included.

Results

The Main Effect of the Comic Condition on Cognitive Engagement

A one-way ANOVA was conducted to examine the effect of comic condition on cognitive engagement (see Appendix C Table C1). Excluding incomplete responses, a final analytic sample of 190 participants were included in the test. Results revealed a significant main effect of condition, $F(2, 187) = 24.271$, $p < 0.001$. Post-hoc Tukey tests indicated that both the one-sided humor condition ($M = 3.98$, $SD = 2.04$, $n = 63$) and the two-sided humor condition ($M = 3.95$, $SD = 1.08$, $n = 62$) led to significantly higher cognitive engagement compared to the control condition ($M = 2.78$, $SD = 1.21$, $n = 65$; see Appendix C, Tables C2 and C3), both $p < 0.001$. However, there was no significant difference in engagement scores between the one-sided and two-sided humor conditions ($p = 0.985$).

Preliminary Check for Dietary Influence

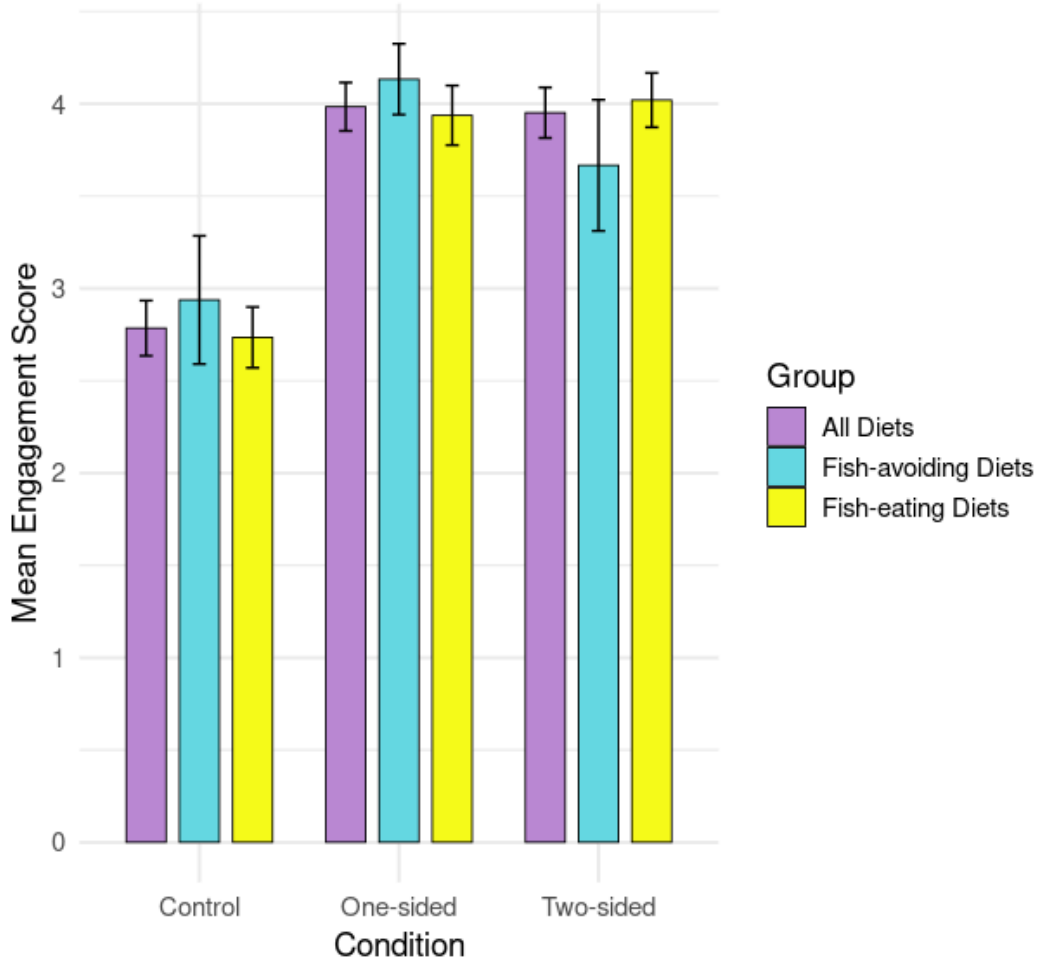
Before proceeding with the main analysis, a preliminary check was conducted to assess whether dietary habits (fish-eaters vs. fish-avoiders) moderated the effect of comic condition on cognitive engagement. This step was taken to determine whether all responses could be validly included in the main statistical analysis, or whether non-fish eaters should be excluded from the analysis.

Mean engagement scores were examined across diet groups and humor conditions as illustrated in Figure 5 and found in Appendix C, Table C4. In the full sample ($N = 190$), participants in both the one-sided ($M = 3.98$, $SD = 1.04$) and two-sided humor conditions ($M = 3.95$, $SD = 1.08$) reported higher engagement than those in the control group ($M = 2.78$, $SD = 1.21$).

This pattern held among fish-eating participants for both the one-sided (M = 3.94, SD = 1.12) and two-sided (M = 4.02, SD = 1.04) condition, in comparison to the control (M = 2.73, SD = 1.15). Among fish-avoiding participants (n = 43), the one-sided humor condition elicited the highest engagement (M = 4.13, SD = 0.74), followed by two-sided (M = 3.67, SD = 1.23) and control (M = 2.94, SD = 1.39).

Figure 5

Mean Cognitive Engagement Scores by Dietary Group and Comic Condition



Post hoc comparisons showed significant differences between the humor and control conditions in the full sample and among fish-eaters (see Table 2). In the fish-avoiding group, only the one-sided condition differed significantly from the control.

Table 2

Tukey Post-Hoc Test Results Comparing Cognitive Engagement Across Comic Conditions, Split by Dietary Group.

Group	Comparison	Diff	Lwr	Upr	P-value	*n*: Control / One-sided / Two-sided
All diets	One-sided vs Control	1.200	0.735	1.664	0.000***	
All diets	Two-sided vs Control	1.167	0.701	1.633	0.000***	65 / 63 / 62
All diets	Two-sided vs One-sided	-0.033	-0.502	0.437	0.985	
Fish-eaters	One-sided vs Control	1.144	0.615	1.674	0.000***	
Fish-eaters	Two-sided vs Control	1.097	0.568	1.627	0.000***	49 / 48 / 50
Fish-eaters	Two-sided vs One-sided	-0.047	-0.526	0.431	0.980	
Fish-avoiders	One-sided vs Control	1.196	0.186	2.206	0.017*	
Fish-avoiders	Two-sided vs Control	0.729	-0.344	1.802	0.236	16 / 15 / 12
Fish-avoiders	Two-sided vs One-sided	-0.467	-1.555	0.622	0.554	

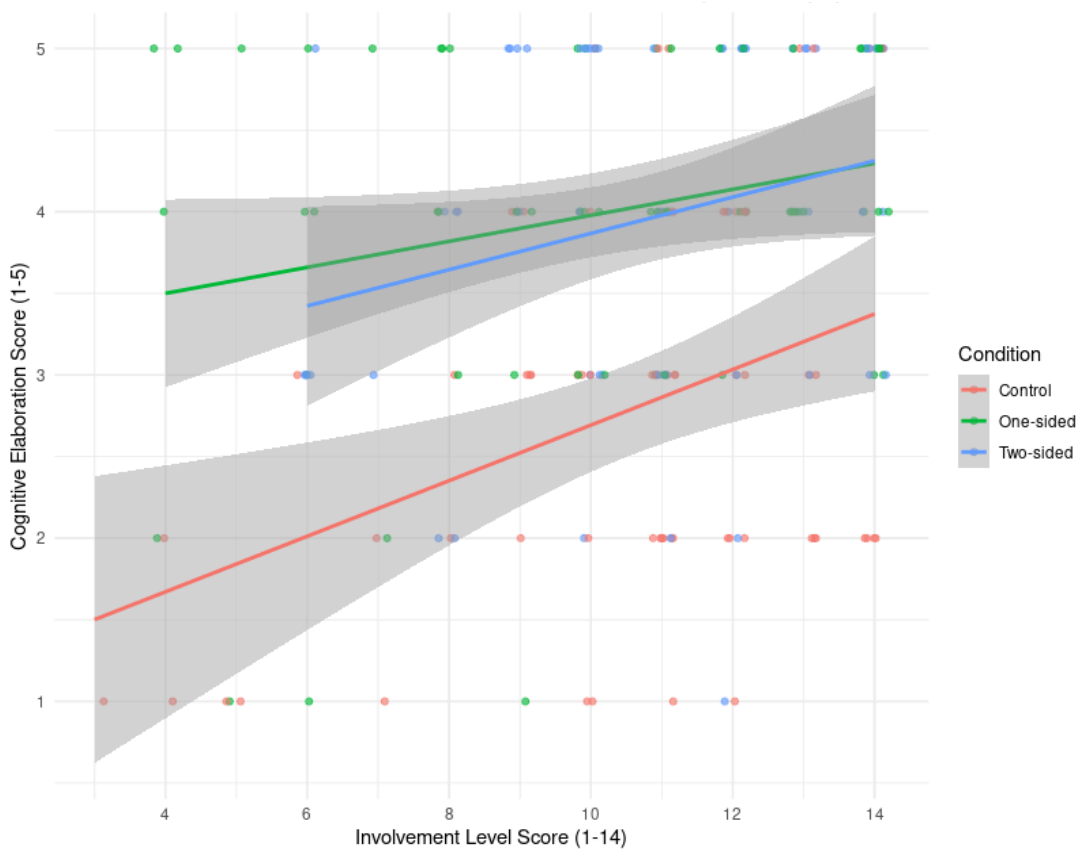
Note. Significance codes: p. < 0.10, p* < 0.01, p** < 0.001, p*** < 0.000.

Involvement Level as a Main Predictor

A linear regression model was conducted to examine the effects of comic condition, involvement level, and their interaction on cognitive engagement (N = 190) (see Figure 6). Results revealed a significant positive main effect of involvement level on engagement ($\beta = 0.17$, $p = 0.001$), such that higher involvement scores were associated with greater cognitive engagement across all comic conditions (see Appendix C Table C5). Both the one-sided ($\beta = 2.19$, $p = 0.003$) and two-sided humor conditions ($\beta = 1.77$, $p = 0.041$) showed significantly higher engagement compared to the control condition. No significant interaction effects were found between involvement level and comic condition ($p > 0.18$), indicating that the effect of involvement level on engagement did not differ by condition.

Figure 6

Effect of Involvement Level on Cognitive Engagement Across Conditions



Note. Figure generated using R; error bars indicate 95% confidence intervals (CI).

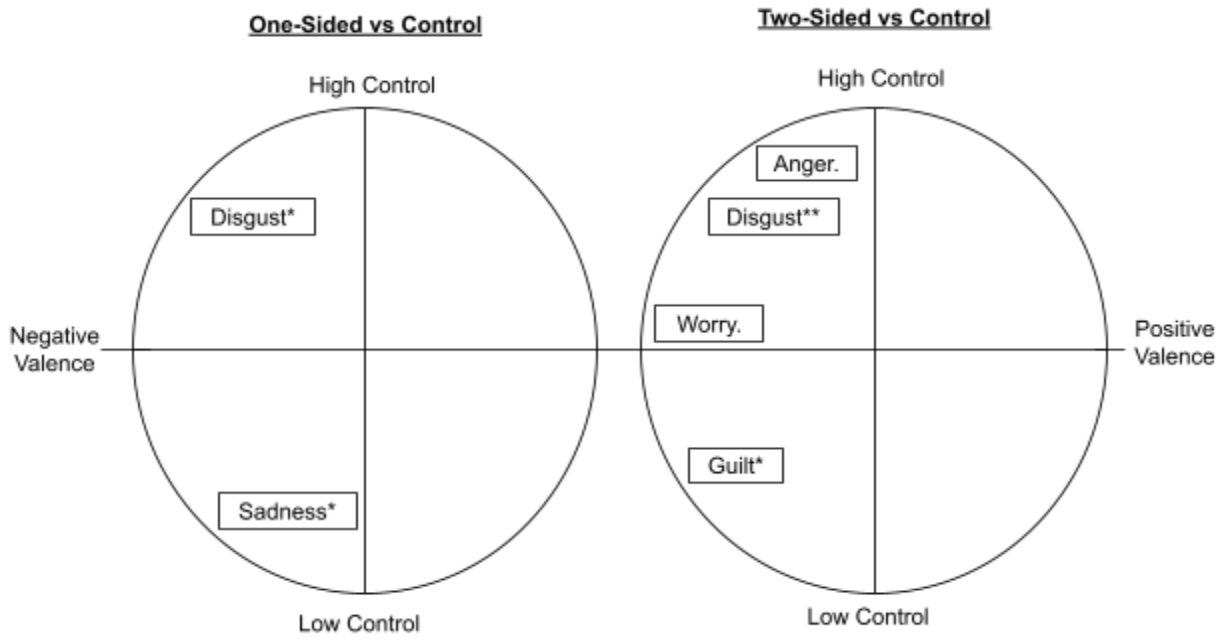
Emotions as Mediators for Cognitive Engagement

A series of causal pairwise mediation analyses were conducted to test whether individual emotional responses mediated the relationship between comic condition and cognitive engagement. Comparisons were made between all conditions (control vs. one-sided, control vs. two-sided, and one-sided vs. two-sided). The analysis identified several significant emotional mediators. For the one-sided humor versus control comparison, Sadness (ACME = 0.114, p = 0.036) and Disgust (ACME = 0.132, p = 0.028) significantly mediated the effect on cognitive engagement. For the two-sided humor versus control comparison, Disgust (ACME = 0.155, p = 0.008), Guilt (ACME = 0.101, p = 0.048), Worry (ACME = 0.142, p = 0.052), and Anger (ACME = 0.132, p = 0.072) were identified as mediators, although Worry and Anger were marginally significant. These results are summarized in the Appendix (as seen in Table C6 of Appendix C).

An additional result was that the average level of Amusement reported in the one-sided condition (M = 3.51, SD = 1.43) was significantly higher compared to the two-sided condition (M = 2.85, SD = 1.53) (see Appendix C, Table C7).

Figure 7

Mapping Significant Causal Mediation Emotions in the GEW model 3.0 Per Condition Comparison.



Note: Diagram created by the author based on Scherer et al. (2013) and significant mediation results as found in the table C6 of Appendix C. Significance codes: p. < 0.10, p* < 0.01, p** < 0.001, p*** < 0.000.

Discussion

This study set out to investigate how humor-based messaging can influence public engagement with the issue of microplastics, with three central aims: first, to assess how different message types– non-humorous, one-sided humorous, and two-sided humorous comics– differ in their ability to prompt deeper reflection on the topic; second, to examine whether one's prior concern about microplastics shapes how they engage with these messages; and third, to explore the emotional mechanisms that may explain why certain messages result in more cognitive engagement than others. The findings demonstrate that the latter two formats, regardless of message structure, are significantly more effective than the control comic in stimulating reflective thought. This suggests that the effect of humor may operate independently of structural variation. Moreover, prior involvement with the topic consistently predicts engagement, but does not moderate the effect of humor, implying that humorous communication can cut across baseline concern levels. Finally, specific emotional responses, particularly negatively valenced and high-control emotions like Disgust, emerge as key mechanisms through which humor drives deeper engagement. The following sections examine these findings in more detail, considering their broader theoretical and practical implications, as well as directions for future research.

Main Effect of Humor on Cognitive Engagement

The results of this study illustrate strong evidence that humorous messaging, regardless of humor type, significantly enhances cognitive engagement. Participants exposed to the humorous comics show more reflective elaboration, indicating that these formats prompt more effortful processing of the message content. Rather than passively acknowledging the issue (e.g., "microplastics are in our food"), participants in the humorous conditions actively interpret and

expand on the message– considering health risks, institutional responsibility, and possible solutions. This increase of reflective reasoning due to exposure to humorous comics indicates that humor can function as a cognitive catalyst in this context. This challenges preliminary evidence (Moyer-Gusé et al., 2011) which posits that humor distracts audiences from engaging with the underlying information. Instead, this study demonstrates that humor is effective in stimulating central route processing (ELM) and that in the context of microplastic awareness, humor can motivate individuals to engage more with the content than non-humorous content.

Despite theoretical distinctions, no significant difference emerges between the one-sided and two-sided comics in their effect on engagement. This finding is particularly notable given that the two humor formats differ structurally: one-sided humor offers a singular, ironic critique, while two-sided humor presents and refutes opposing viewpoints.

An explanation may lie in humor's powerful ability to stimulate thoughtful reflection. Previous research has shown that humor, regardless of type, can ease message reception, and heighten curiosity in topics that might otherwise be uninteresting for audiences. Another possibility is that the differences between humor types do exist, but their impact on engagement is relatively subtle. While theoretical models suggest that humor structure (one-sided vs. two-sided) can influence how audiences process messages, such effects may require larger sample sizes or more targeted audiences to detect. In the current study, the shared use of irony, visual exaggeration, and emotional resonance in both conditions may have overshadowed the structural nuances in humor type.

Preliminary Check for Dietary Influence

The presence of a significant relationship between the humorous conditions and cognitive engagement prompted an additional, preliminary analysis of whether dietary habits had any influence on the latter. This provided insight as to whether personal relevance to the scenario portrayed in the comic– fish consumption– moderated the effect of humor on cognitive engagement, specifically for non-fish eaters.

Among fish eaters, exposure to either humorous comic led to significantly greater cognitive engagement than the control condition, mirroring the main effect found in the full sample. In contrast, within the smaller fish-avoidant group, only the one-sided humor condition produced a statistically significant increase in engagement compared to the control comic, while the two-sided humor condition did not. Although the average engagement score for fish-avoiders who received the two-sided comic was higher than that of the control comic by approximately 0.7 points, the lack of significance is likely attributed to the small subgroup exposed to the two-sided comic (control, n = 16; two-sided n = 12), limiting statistical power.

Interestingly, as shown in Figure 5 the average cognitive engagement score among fish-avoiders exposed to the one-sided humor comic was higher than that of fish-eaters exposed to the same condition. Therefore, these findings support the robustness of humor's cognitive impact across diverse audience profiles and suggest that dietary habits did not meaningfully moderate the overall relationship between comic type and engagement. This also suggests that even among non-fish eaters, the underlying message of the comic still resonated and led to statistically similar cognitive engagement scores. The central pattern remained consistent and dietary habits did not significantly moderate the effect of comics on cognitive engagement. For this reason, the subgroup of non-fish eaters was kept in the further analyses.

Involvement Level as a Predictor of Cognitive Engagement

In addition to humor's main effect, this study finds that individuals' prior involvement with the issue of microplastics positively predicts cognitive engagement across all conditions. That is, participants who report greater personal concern about microplastics also demonstrate deeper reflection, regardless of whether they were exposed to a humorous or non-humorous message (see Figure 6). This aligns with the ELM which posits that individuals who are personally invested in an issue are more motivated to process related information.

Beyond interaction as a main predictor of cognitive engagement, no interaction effect emerges between involvement-level and comic condition, meaning that depending on comic condition, the effect on cognitive engagement is equally strong for both low- and high-involvement individuals. This is notable, as prior studies often suggest that humor type must be matched to the audience's level of concern. Namely, the notion that two-sided humor is more persuasive for low-involvement individuals due to its refutational structure, while one-sided humor resonates more with high-involvement individuals (Becker & Anderson, 2019; Allen, 1991).

These findings contribute to literature by identifying a potential boundary condition in existing models of humor processing and persuasion: in high-salience domains like health, the influence of humor may override individual differences in baseline involvement. While preliminary studies suggest that humor type must be matched to involvement level to maximize persuasive impact, this study finds that when message content carries inherent personal relevance– such as health risks– humorous framing can be broadly effective regardless of prior concern. Although prior involvement predicts cognitive engagement across all comic conditions,

the effectiveness of humor is not moderated by involvement level. This refines our understanding of how involvement interacts with message framing, highlighting the importance of topic salience in shaping persuasive outcomes, and suggesting practical value. That when communicating health-related risks, humor may offer a widely applicable strategy, reducing the need for narrowly tailored messages based on involvement segmentation.

Emotions as Pathways for Cognitive Engagement

In the pairwise causal mediation analyses, several negatively valenced emotions significantly mediate the relationship between comic condition and cognitive engagement, particularly when comparing humorous comics to the non-humorous control (see Table B2 in Appendix B). Compared to the control condition, participants exposed to the one-sided humorous comic report greater cognitive engagement partially due to the emotions of Sadness and Disgust. In the two-sided humor versus control comparison, Disgust and Guilt are significant mediators, while Worry and Anger show marginal significance.

These findings indicate that five emotional responses play a mediating role in how different types of humor increase cognitive elaboration. Drawing from the GEW model 3.0 (Scherer et al., 2013), the emotional mediators identified in this study are interpreted through the two dimensions of valence (positive vs. negative) and perceived control (low vs. high). Additionally, they are interpreted through the lens of the extent of certainty they elicit.

Across comparisons, an overall pattern emerges in which only negatively valenced emotions mediate the relationship between comic condition and increased cognitive engagement (see Figure 7). Namely, Sadness, Disgust, Guilt, Worry, and Anger. This suggests that emotional discomfort plays a key role in motivating participants to think more deeply about the issue of

microplastics. The emotional discomfort elicited by negative emotions can trigger efforts to resolve inner conflict therefore leading to more engagement with the topic. Notably, no positively valenced emotions emerged as significant mediators in any comparison. This absence may indicate that although positive emotions can increase amusement or draw initial attention, they might lack the emotional urgency required to trigger more reflective thought. It is therefore plausible that positive emotional responses alone do not account for the observed increase in cognitive engagement, as they may be too light-hearted and distract from the underlying message. This supports prior findings by Mackie and Worth (2020), which suggest that positive emotions can reduce motivation for effortful thinking by signaling a safe or unproblematic environment. Nevertheless, although none of the positive emotions explained a partial increase in cognitive engagement, they may still be essential in priming the audience to feel and process the harder-hitting, negatively valenced emotions that motivate deeper reflection.

The perceived control dimension offers additional insights. Among these, Disgust emerges as particularly noteworthy: it is the only emotion that is highly significant and that mediates cognitive engagement across both humorous conditions, making it a consistent affective pathway in this exploratory research. Emotions such as Sadness and Guilt, associated with low control, may initially evoke a sense of helplessness or vulnerability. This emotional tone may encourage passive rumination rather than constructive engagement. In contrast, Disgust is categorized by the GEW as having high perceived control, implying a sense of agency and the ability to respond to the issue. Although Worry and Anger also serve as mediators in the same GEW quadrant, their effects are only marginally significant and emerge only in the two-sided humor versus control comparison. By contrast, the strong and consistent mediation effect of

Disgust across both humorous conditions highlights its unique role in driving increased cognitive engagement.

One explanation for Disgust's effectiveness could be that this dual emotional experience of high discomfort (negative valence) coupled with actionability (high control) prompted more engagement than emotions marked by low perceived control, such as Sadness or Guilt, which may lead to more passive responses. This study therefore suggests that emotions that fall within the high-control, negative valence quadrant of the GEW 3.0 model could represent a particularly effective emotion-profile for mobilizing audience thought, especially around health-related risks like microplastics. Additionally, these findings clarify contradictory literature on the effects of certain versus uncertain emotions and how they influence cognitive engagement (Strick, 2021; Smith & Ellsworth, 1985; Tiedens & Linton, 2001). In the context of health-risk framing, this study supports the notion that both certain (e.g., Disgust) and uncertain (e.g., Sadness) emotions can lead to an increase in cognitive engagement. Thereby refuting the assumption that predominantly uncertain emotions lead to an increase in cognitive engagement (Smith & Ellsworth, 1985; Tiedens & Linton, 2001).

Another explanation for Disgust's prominent significant result lies in the physical and literal nature of the emotion. Disgust may have been more strongly activated because it is both visually and conceptually embedded in the comics: the physical act of consuming microplastics through contaminated fish elicits a visceral response, while the broader awareness that this contamination is normalized in everyday life evokes moral or existential unease. This combination of literal imagery and symbolic significance likely intensified the emotional impact, making the experience of Disgust particularly dominant among the participants of both humorous comics. As a result, Disgust not only triggers an aversive emotional reaction but also

motivates individuals to mentally confront the issue. This therefore supports the claims of prior literature (Cline & Kellaris, 2007) that humor closely tied to the issue itself– also known as related humor– enhances message impact. This also demonstrates that comics, among other visual media, can help elicit stronger emotions especially when the scenario visualized is related to a direct consequence of the underlying issue.

Practically, these findings hold several implications for a range of stakeholders. They suggest that interdisciplinary collaboration– particularly between visual artists, communication professionals, and scientists, is instrumental in designing attention-grabbing, impactful, humorous content that resonates with the public. If institutions, health communicators, climate scientists or creative professionals aim to raise awareness about health risks they should consider using issue-relevant humor that elicits targeted emotional responses. In particular, evoking high-control, negatively valenced emotions– such as Disgust– may be especially effective in promoting deeper cognitive engagement. More broadly, the results highlight the value of emotional calibration in engaging audiences with a message.

Building on these findings, future research should empirically examine whether the various quadrants of the GEW 3.0 produce distinct effects on cognitive elaboration. In particular, studies could investigate whether emotions characterized by negative valence and high control constitute an optimal emotional profile for fostering deeper engagement and potentially also other actionable outcomes (e.g., behavioural intentions). Such research would help clarify the mechanisms by which specific emotional responses drive audience involvement and inform more effective communication strategies.

While this study only tests individual emotional mediators, it does not rule out the possibility that a broader spectrum of emotions– spanning both positive and negative valence or

varying levels of control– could collectively strengthen cognitive engagement. For example, positive emotions may still play an indirect or complementary role by capturing attention or increasing message receptivity, even if they independently do not account for increased elaboration. Emotionally mixed states may encourage deeper reflection by generating a type of internal tension or dissonance, which motivates audiences to resolve uncertainty through further thought. Although not in the scope of this study, future research could explore whether greater emotional complexity enhances cognitive engagement when emotions are elicited simultaneously.

Interpreting Emotion Elicitation in One- vs. Two-Sided Humor

While the mediation analyses cannot definitively explain why the humorous conditions differ in the range of emotions they evoke, some interpretative insights can be drawn. The one-sided humorous comic depicted a highly ironic romanticization of eating microplastics (see Figure 2). This portrayal may have elicited Sadness due to its reflection on the normalization of microplastic pollution in our food. In contrast, the two-sided comic introduced a refutational structure which may have led to more complex emotional responses (see Figure 3). The character's worried and somewhat ambiguous facial expression, combined with the scenario of being served a fish containing microplastics, could have led participants to imagine themselves in her position– potentially eliciting Anger directed at the restaurant for serving contaminated food. The ambiguity of her expression may also have contributed to the emergence of Guilt, as well as Worry, by highlighting the personal and societal seriousness of the issue. This broader emotional mix suggests that the counterargument in the two-sided humorous comic prompted a

more mixed affective reaction. Disgust in both humorous conditions, was likely triggered by the theme of ingestion and microplastic contamination.

Interestingly**,** participants exposed to the one-sided comic reported significantly higher levels of Amusement compared to those who viewed the two-sided comic (see Appendix B, Table B8). This thereby supports the idea that one-sided messages are generally perceived as more favorable and entertaining than refutational two-sided messages (Allen, 1991). Notably, even the control comic elicited a higher average Amusement score than the two-sided condition. The lower Amusement observed in the two-sided comic may be attributed to its refutational structure, which arguably over-explains the joke and reduces its comedic impact. The obviousness of the undesirability of microplastics in food, coupled with the expected shocked facial expression of the restaurant guest, likely diminished the element of incongruence and, consequently, the humor.

These findings underscore a nuanced picture of how humor type influences emotional responses. While one-sided and two-sided humorous comics elicited different emotional profiles, overall, they were both equally effective in stimulating cognitive elaboration compared to the control comic. This suggests that there is no necessary tradeoff between amusement and cognitive engagement: humor can simultaneously entertain and prompt deeper reflection. On a practical level, the one-sided humorous comic presents a more favorable message framing, as it elicits greater amusement– an emotional response that can enhance memorability and other behavioural intentions (e.g., likelihood of sharing the comic with others) (Giuliani, McRae & Gross, 2008). Although the two-sided comic yields equal cognitive engagement, its lower amusement levels may limit its broader communicative impact. This suggests that one-sided

humorous message framing may be more effective in campaigns aiming to maximize cognitive engagement, memorability, and message diffusion.

Limitations

This exploratory study offers valuable insights into the role of humor, involvement level, and emotions in communicating microplastic-related health risks, but several limitations remain important to acknowledge.

First, although the control comic is intended as a neutral comparison, it still elicits emotional responses and cognitive engagement. This may be due to the comic format itself, which adds narrative and visual elements that naturally prompt interpretation– even in the absence of humor. To more clearly isolate the effect of humor, future work should consider using a simpler control condition, such as a plain, text-only factual message.

Second, the use of non-random, convenience sampling limits the generalizability of these findings. The sample, drawn largely from the researcher's network and university-affiliated channels, skews toward younger and more educated individuals. While this broad, untargeted approach is suitable for identifying general patterns, future research should consider more representative or demographically diverse samples to evaluate how different audiences respond to humor-based messaging across variables like age, education, or cultural context.

Third, the analytical approach for testing emotional pathways relies on pairwise causal mediation analysis, which examines each emotion separately across condition comparisons. This method introduces the risk of Type I error due to multiple unadjusted tests, and Type II error by potentially overlooking the combined or interactive effects of emotions. In future work, more integrative statistical techniques such as multiple mediation models or structural equation

modeling should be considered to capture the complex emotional mechanisms that underlie engagement.

Another limitation relates to the study's practical validity. This study assumes participants would naturally stop, view the comic, and cognitively engage with its message– however such attention cannot be guaranteed outside of the research context. Additionally, participants were asked to write down any thought they had after viewing the comic. Although the prompt was neutrally worded to minimize bias, this request may have subtly primed participants to reflect more deeply than they otherwise would have. Future research could address this by simulating more natural exposure conditions, or by incorporating passive measures of attention to better understand how humor-based messages perform in everyday media environments.

Finally, the study assumes that the comics are perceived as humorous, but humor is inherently subjective. Participants likely varied in how funny they found the material, which may have influenced both their emotional and cognitive responses. Given this variation, it is important to interpret the findings with caution and consider incorporating pretesting of humorous materials or additional measures of humor appreciation to better understand how perceived funniness shapes audience engagement.

Conclusion

This study explored how different types of humorous messages influence cognitive engagement in the context of microplastic health risks. It compares three comic formats: an informative, non-humorous comic (control), a humorous comic using ironic exaggeration (one-sided), and a humorous comic presenting opposing views (two-sided). It also examines whether emotional responses shape engagement, and whether prior concern about microplastics predicts deeper reflection on the issue. As microplastics represent an emerging public health concern with long-term consequences that remain uncertain, this study considers how humor can facilitate awareness as the issue gains urgency over time.

Findings from the online survey of 205 participants show that both humorous comics significantly increase cognitive engagement compared to the control, regardless of a participant's initial level of concern. This challenges the idea that humor distracts from or trivializes serious topics. Instead, the results show that amusement and critical reflection can coexist. Although both humor types are effective, the one-sided comic proves more favorable, eliciting greater amusement– an emotion often linked to stronger message recall and increased likelihood to share.

Notably, negatively valenced emotions, especially those with high perceived control such as Disgust, play a central role in motivating engagement. These emotions create a sense of discomfort or tension that prompts more effortful cognitive processing. While amusement may open the door to receptivity, it is these uncomfortable emotions that drive deeper reflection on the issue. Future research should therefore explore how combinations of emotions, rather than examining each emotion in isolation, might jointly contribute to cognitive engagement.

These findings show that humor, along with its engaging visuals and emotional appeal, can re-engage audiences to think and care more deeply about health issues. In an era of information overload, where attention is fragmented and urgency often diluted, humorous formats offer a communicative edge. Humor is subjective, but simple and clear humor is effective across broad audiences. This interdisciplinary approach, combining innovative communication strategies with scientific content, is vital. This study illustrates humor as a powerful tool for connecting people to complex issues in ways that resonate and empowers them to protect themselves and their communities.

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Appendix A

Descriptive Statistics of Demographic Variables

Table A1

Participant Gender Distribution

Gender	Count	Percent
Female	122	59.5
Male	73	35.5
Non-binary / third gender	4	2.0
Prefer not to say	4	2.0
NA	2	1.0

Table A2

Participant Age Summary

Mean	SD	Min	Q1	Median	Q3	Max	IQR
28.34	13.41	18.00	21.00	22.00	27.50	76	6.50

Table A3

Participant Occupation Distribution

Occupation	Count	Percent
Student	130	63.4
Employed (working full/part-time)	64	31.2
Unemployed	4	2.0
Retired	3	1.5
Other or NA	3	1.5

Stay-at-home parent/caregiver	1	0.5

Table A4

Countries Represented by Participants

Country	Count	Percent
Netherlands	76	38.0
Germany	32	16.0
Ireland	10	5.0
India	8	4.0
Italy	8	4.0
Australia	7	3.5
Canada	4	2.0
Belgium	3	1.5
Estonia	3	1.5
France	3	1.5
Japan	3	1.5
Poland	3	1.5
Portugal	3	1.5
Ukraine	3	1.5
United States of America	3	1.5
Azerbaijan	2	1.0
Malaysia	2	1.0
Romania	2	1.0
Spain	2	1.0

Sweden	2	1.0
Switzerland	2	1.0
Turkey	2	1.0
United Kingdom of Great Britain and Northern Ireland	2	1.0
China	1	0.5
Colombia	1	0.5
Czech Republic	1	0.5
Lebanon	1	0.5
Luxembourg	1	0.5
Mexico	1	0.5
Philippines	1	0.5
Serbia	1	0.5
Singapore	1	0.5
Sint Maarten	1	0.5
Slovakia	1	0.5
South Africa	1	0.5
South Korea	1	0.5
Suriname	1	0.5
United Republic of Tanzania	1	0.5

Note. Question item: “Where are you from”.

Table A5

Participant Dietary Preferences

Diet	Count	Percent

Omnivore	110	53.7
Flexitarian	49	23.9
Vegetarian	27	13.2
Vegan	6	2.9
Carnitarian	6	2.9
Other / NA	3	1.5

Note. Count and percentage of participants by self-reported diet type.

Appendix B

Descriptive Statistics for Variables

Table B1

Mean and SD of Engagement_Score

Variable	Mean	SD
Engagement_Score	3.56	1.24

Table B2

Mean and SD of Involvement_Level_Score

Variable	Mean	SD
Involvement_Level_Score	10.41	2.69

Table B3

Means and SD of Emotions

Emotion	Mean	SD
Interest	3.82	1.21
Amusement	3.20	1.45
Pride	1.38	0.79
Joy	1.64	0.96
Pleasure	1.65	0.98
Contentment	1.45	0.81
Love	1.21	0.58
Admiration	1.44	0.79
Relief	1.27	0.69

Compassion	2.04	1.27
Sadness	3.78	1.51
Guilt	3.04	1.65
Regret	2.61	1.56
Shame	2.90	1.66
Disappointment	3.79	1.71
Worry	4.20	1.55
Disgust	3.44	1.66
Contempt	1.87	1.30
Hate	2.06	1.40
Anger	2.81	1.52

Note. All emotions adopted from the Geneva Emotion Wheel (3.0)

Appendix C

Statistical Research Results

Table C1

One-way ANOVA Results Examining the Effect of Comic Condition on Cognitive Engagement

	Df	Sum Sq	Mean Sq	F value	Pr(>F)	*n*
Condition	2	59.919	29.960	24.271	0.000***	190
Residuals	187	230.824	1.234	-	-	-

Note. Significance codes: p. < 0.10, p* < 0.01, p** < 0.001, p*** < 0.000.

Table C2

Tukey Post-Hoc Test Results Comparing Comic Conditions on Cognitive Engagement

Comparison	Diff	Lwr	Upr	P-value	*n*: Control / One-sided / Two-sided
One-sided vs Control	1.196	0.736	1.664	0.000***	
Two-sided vs Control	1.167	0.701	1.633	0.000***	65 / 63 / 62
Two-sided vs One-sided	-0.033	-0.502	0.437	0.985	

Note. Significance codes: p. < 0.10, p* < 0.01, p** < 0.001, p*** < 0.000.

Table C3

Descriptive Statistics for Cognitive Engagement Across Experimental Conditions

Condition	Mean engagement	SD engagement	*n*
Control	2.78	1.21	65
One-sided	3.98	2.04	63
Two-sided	3.95	1.08	62

Table C4

Mean Engagement Scores and Standard Deviations by Diet Group and Condition

Group	Condition	Mean	SD	*n*
All diets	Control	2.78	1.21	65
All diets	One-sided	3.98	1.04	63
All diets	Two-sided	3.95	1.08	62
Fish-eating Diets	Control	2.73	1.15	49
Fish-eating Diets	One-sided	3.94	1.12	48
Fish-eating Diets	Two-sided	4.02	1.04	50
Fish-avoiding Diets	Control	2.94	1.39	16
Fish-avoiding Diets	One-sided	4.13	0.743	15
Fish-avoiding Diets	Two-sided	3.67	1.23	12

Table C5

Linear Regression Predicting Engagement from Humor Condition, Involvement Level, and Their Interaction

Term	Estimate	Std. Error	t-value	p-value
Intercept	0.990	0.566	1.75	0.082
One-sided (vs. control)	2.191	0.735	2.98	0.003**
Two-sided (vs. control)	1.766	0.857	2.06	0.041*
Involvement level score	0.170	0.052	3.26	0.001**
One-sided x Involvement level	-0.091	0.069	-1.32	0.188
Two-sided x Involvement level	-0.059	0.078	-0.75	0.452

Note. Reference category for the conditions (one-sided and two-sided) is the control condition. Significance codes: p. < 0.10, p* < 0.01, p** < 0.001, p*** < 0.000.

Table C6

Comparative Causal Mediation Analysis of Emotional Mediators in Condition Effects on Cognitive Engagement

Condition Comparison	Emotion	ACME Estimate	ACME p-value	Prop. Mediated	*n*
Control vs One-sided	Sadness	0.114	0.036*	0.092	125
Control vs One-sided	Disgust	0.132	0.028*	0.109	127
Control vs Two-sided	Disgust	0.155	0.008	0.130	126
Control vs Two-sided	Guilt	0.101	0.048*	0.087	125
Control vs Two-sided	Worry	0.142	0.052.	0.120	126
Control vs Two-sided	Anger	0.132	0.072.	0.111	122

Note. Significance codes: p. < 0.10, p* < 0.01, p** < 0.001, p*** < 0.000.

Table C7

Descriptive Statistics of Significantly Different Emotions

Condition	Mean Amusement	SD Amusement
Control	3.24	1.34
One-sided	3.51	1.43
Two-sided	2.85	1.53

Note. Significance codes: p. < 0.10, p* < 0.01, p** < 0.001, p*** < 0.000.