

A comparative study of frames and narratives identified within scientific press releases on ocean climate change and ocean plastic

Aike N. Vonk, Mark Bos, Ionica Smeets and Erik van Sebille

Abstract

To understand how scientific institutions communicate about ocean climate change and ocean plastic research, 323 press releases published between 2017 and 2022 were analyzed. A clustering method revealed 4 ocean climate change and 5 ocean plastic frames that were analyzed qualitatively. Ocean plastic was presented as a biological and health issue, placing an emphasis on solutions and society's obligation to implement them. Ocean climate change was framed as environmental and socio-economic problem, highlighting politics' responsibility for mitigation. Narratives were only used to personify science and represent scientists, indicating that future press releases could include more social dimensions to engage audiences in ocean issues.

Keywords

Environmental communication; Representations of science and technology; Science and media

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Introduction

The ocean is important to life on Earth. It produces oxygen, regulates climate, and provides food and energy. Anthropogenic influences such as rising temperatures [IPCC, 2022] and increasing amounts of plastic [van Leeuwen, Walker & Vince, 2022] threaten ocean health. While the issues of plastic pollution and climate change are intrinsically connected, both through the ecosystems facing threats and the shared root cause of overconsumption of finite resources, they compete for public and policy attention [Ford et al., 2022].

Worldwide, differences exist in how people assess the seriousness of ocean problems such as climate change and ocean plastic. In many countries, ocean pollution is seen as the biggest threat to ocean health, while the severity of ocean climate change is not recognized as such [Lotze, Guest, O'Leary, Tuda & Wallace, 2018]. In example, Tiller and colleagues [2019] found that there is more media representation on ocean plastic than on ocean climate-related issues such as ocean

acidification, while more scientific studies are conducted on the latter. This raises concerns that the over-representation of ocean plastic in the media “*pushes the climate debate off the table*” [Stafford & Jones, 2019].

Science news in the media is often based on press releases from universities and publishing houses, which are themselves based on published or ongoing research [Autzen, 2014; Vogler & Schäfer, 2020]. Science communicators who write press releases can therefore play an important role in helping the public understand current environmental issues, as they act as ‘interpreters’ of scientific studies. According to UNESCO [2021], good science communicators should not only explain the science behind issues but also relate scientific research to what is known to the public.

Making scientific research interesting and relatable to the public, can be done by the use of frames and narratives. Frames create a context in which information can be interpreted [Entman, 1993], thereby making it easier to understand complicated data [Nisbet, 2009]. Narratives can be used to create a familiar reference for audiences [Dahlstrom, 2014], and make information more interesting and relatable to the reader [Cherniak, Nisbett & Ross, 1983]. Understanding how scientific organizations use frames and narratives to popularize their research enables us to gain insight into how these frames impact the representation of ocean science in the media. This is a first step in understanding how possible differences in communication styles may affect people’s perception of ocean climate change and ocean plastic.

There has been extensive research on how climate change [Bolsen & Shapiro, 2018], and to a lesser extent ocean plastic [Henderson & Green, 2020; Schönbauer & Müller, 2021; Welzenbach-Vogel, Werling, Barkela & Milde, 2022], are framed in the media. One study analyzed how large American companies frame climate change in press releases, finding the discourse to be largely expert-oriented and technocratic, with no attention to values and identification [Wetts, 2020]. This study did not look at scientific organizations, and to date no study has analyzed how ocean plastic and ocean climate change are framed by research institutions and how frames and narratives differ between these two topics.

In this paper, we present the results of our content analysis of press releases. The work described here involves an overview of often-used climate change and ocean plastic media frames, the development of a reliable coding scheme for the analysis of scientific press releases, and the application of a statistical clustering method to identify frames. Based on our results, we propose a set of frames used by scientific organizations to describe ocean plastic and ocean climate change research. In addition, we discuss how narratives are incorporated in press releases. In the final discussion and conclusion, we highlight the differences between ocean plastic and ocean climate change press releases, reflect on existing literature, and consider implications for future research.

Theoretical framework

Narratives in science coverage

Science journalists use narratives to make a topic appealing and recognizable for audiences [Dahlstrom, 2014]. Narratives give insight in *how* a story is told by

involving elements such as emotion, stylistic devices and personalization [Glaser, Garsoffky & Schwan, 2009]. Scientists are also found to use narratives when writing about research and it is even suggested that using a more narrative writing style increases the uptake and influence of articles regarding climate change research [Hillier, Kelly & Klinger, 2016]. This leads to research question 1: What narrative writing styles are used to communicate about ocean plastic and ocean climate change research, and do these differ between the two topics?

It is expected that some press releases use a narrative writing style more heavily than others since some press releases will only state the results and conclusions of a scientific study whereas others pay attention to who conducted the research and describe the emotions of the scientists involved. We thus consider narration to be a gradual concept, in which press releases contain narrative elements in varying degrees that can be measured as 'degree of narrativity' [Lück, Wessler, Wozniak & Lycarião, 2018; Wozniak, Lück & Wessler, 2015].

Studies measuring narrativity often base their work on Glaser et al. [2009] who deduced from narrative theory and psychological models of narrative impact four factors that measure the narrativity of a story:

- Dramatization is the process of organizing narrative content. In recognizing dramatization, we follow [Zerba, 2008] who distinguishes factual news from narratives by looking if a story is written in the typical inverted pyramid style known from classic news stories and scientific writing or, if the story highlights a sequence-of-events that lead to a clear plot, which indicates a more narrative story structure.
- Personalization creates a way of communicating abstract scientific concepts within a frame of reference, focusing on a particular individual or smaller group of people and exploring their actions and the consequences these uphold [Schiffer & Guerra, 2015].
- Emotionalization is used to present information in an emotional way.
- Stylistic devices are used to make a text more interesting and lively, for instance by including metaphors or analogies. Metaphors are often used in science- or climate communication to explain complicated information or communicate about matters '*beyond human scale*' [Dahlstrom, 2021; Forgács & Pléh, 2022].

In narratives, story tone is important. Because tone adds to the way the author presents the story in a negative or positive manner, thereby influencing the way people experience the story. This is not without risks, as past research showed that too many hopeful messages have the chance that they dilute the urgency and extent of environmental problems [Hornsey & Fielding, 2016]. In contrast, negative stories can lead to pessimism in environmental behavior, caused by the belief that the ocean is beyond restoration [Duarte et al., 2015]. However, there are also positive examples, as shown by Kelly et al. [2022] and McAfee, Doubleday, Geiger and Connell [2019], who showed that positive stories can inspire people to work together to solve urgent marine environmental issues. Due to the influence story tone can have on people's perception of a story, we are interested to answer research question 2: Do press release authors use a dominant tone when writing ocean science press release?

The social dimensions of press releases are described in the narrative by personalization and actor roles. Personalization makes it possible for the audience to identify with a situation and to feel empathy for the characters involved [Dahlstrom, 2014]. Schwarze [2006] created a way to characterize the characters in environmental communication, according to three classical narrative roles of 'victim', 'villain', and 'hero'. It is said that to increase public awareness and encourage pro-environmental attitudes and behaviors toward the ocean, ocean-related communications should place emphasis on the human and social dimensions of the ocean [Catalano, Lyons-White, Mills & Knight, 2019; Stoll-Kleemann, 2019]. This leads to research question 3: Do press releases emphasize the human and social dimensions of ocean issues by the use of personalization and actor roles?

Frames in science coverage

Framing means that certain features in a text are emphasized over others to promote a particular interpretation [Entman, 1993]. Framing thus creates a context for the receiver to interpret a message, thereby not only shaping issues but also recommended behaviors [Pelletier & Sharp, 2008]. The frames used in the media to communicate about ocean climate change and ocean plastic are found to shape public attitudes toward ocean health in general [Kelly et al., 2022] and ocean plastic [Bailey, 2022; Kelly et al., 2022] and climate change [Cooper, 2011; Schmidt, Ivanova & Schäfer, 2013] in particular. What we do not know, however, is how research organizations frame ocean climate change and ocean plastic research in their press releases and if these frames differ from media frames. Hence, we want to answer research question 4: What frames are used by research organizations to communicate about ocean climate change and ocean plastic research and how do these frames relate to media frames?

Bolsen and Shapiro [2018] summarized five types of frames that are most commonly used in American media to describe climate change, which are: issue frames, opportunity frames, morality frames, science frames, and efficacy frames. Economic impact, environmental impact, disaster, political conflict, national security, and public health are the most prevalent issue frames [Nisbet, 2009; O'Neill, Williams, Kurz, Wiersma & Boykoff, 2015]. In comparison to studies defining climate change media frames, the framing of ocean plastic has received less attention in literature. Some studies do describe how ocean plastic is presented in the media, and state that a focus is placed on risks, damages and negative outcomes caused by ocean plastic, rather than on opportunities, benefits and positive outcomes of plastic use [Welzenbach-Vogel et al., 2022]. Other research showed that ocean plastic is presented as a problem that affects marine life rather than as a threat to human health. The focus in newspaper articles is placed on wildlife entanglement, which may support the idea that macroplastics rather than microplastics are the main issue and that most people are not directly affected by ocean plastic in their daily lives [Henderson & Green, 2020]. Microplastics are described as "*risky objects*" for both the environment and public health and are subject of discussion in the media. In newspaper articles, emphasis is placed on scientific knowledge, risk, and societies responsibility to address risks, which places the responsibility for mitigation on consumers and policy while the responsibility of industry seems almost absent [Schönbauer & Müller, 2021].

Although above-mentioned studies describe how ocean plastic is presented in the media, these studies rarely use the word ‘framing’, meaning that a general characterization of frames, like the one provided by Bolsen and Shapiro [2018], is lacking. This makes it difficult to compare how the topics of ocean climate change and ocean plastic are framed based on existing literature. Hence, we will compare the frames found in this study to answer research question 5: Do research organizations frame ocean climate change- and ocean plastic research differently?

Method

Sample

This study analyzed a total of 323 press releases published on EurekAlert! between January 2017 and December 2021. EurekAlert! is a nonprofit news-release distribution platform run by the American Association for the Advancement of the Sciences (AAAS). EurekAlert! was picked as source, due to their policy that no press releases are changed, implying that framing in press releases is completely created by the sending institution. 2017 was chosen as start date, because this is the first year a substantial number (10 press releases) about ocean plastic were published. The sample was compiled using the search terms ‘ocean + plastic’ and ‘ocean + climate’, which needed to be present in the article’s headline, sub-title or first paragraph. In total 235 press releases on ocean climate change and 88 on ocean plastic were retrieved. The press releases on ocean climate change were sent from 129 different organizations in 18 different countries. Ocean plastic press releases came from 65 organizations in 9 different countries (Figure 1).

CodeBook development

Coding narratives

To determine narrative elements, we created a codebook¹ that describes how tone, actor roles and degree of narrativity can be recognized in press releases. In each press release, actors could fill a ‘victim’, ‘villain’, or ‘hero’ role [Schwarze, 2006]. In the coding scheme, a victim is defined as someone adversely impacted by characters or events, a villain negatively affects others or the world, and a hero is characterized by helping others or conquering challenges. It turned out that some actors did not fit into any of the three classical actor roles, but did fill a distinctive role in which they warned society about ocean plastic or ocean climate change. Consequently, we added the ‘warner’ role. We also coded which actors were quoted in the press release, and if these actors were scientists who were involved in the study or if they were independent actors. In addition it was coded if the quote contained the actor’s opinion.

To code story tone, we did not only want to look at if a story was positive, negative or neutral, but also wanted to have an idea if ‘doom and gloom’ language was used in the communication of ocean science. Hence, we followed the approach of Lück et al. [2018] and Wozniak et al. [2015], and coded besides a positive, negative and neutral tone, also an alarmist/fatalistic or excited/passionate tone when the text used superlatives or ‘doom and gloom’ language resembled by words like ‘crisis’ or ‘disaster’.

¹The codebook is added to the additional online material.

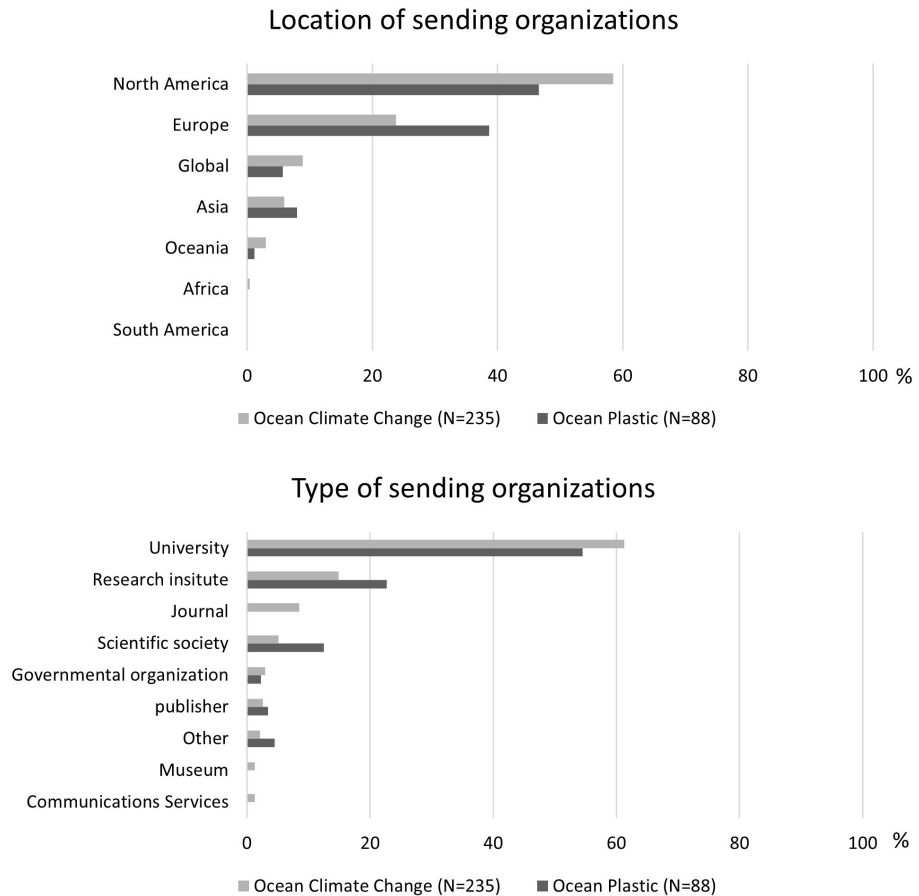


Figure 1. Organizations that published press releases on EurekAlert! and the continents in which they are located. Other organizations include: aquaria, environmental advocacy groups and foundations. Some press releases were sent from global organizations; therefore, no specific continent is listed.

The degree of narrativity was calculated for each press release based on the four factors indicating narratives as proposed by Glaser et al. [2009]. In the texts, *dramatization* was coded when the story was not written according to the traditional inverted pyramid style but was more compliable to a classical story structure with an introduction, middle and plot. When a person took a particular action or was affected by the actions of others or natural phenomena, *personalization* was coded. *Emotion* was said to be present when an actor’s feelings were explicitly mentioned and *stylistic* devices were coded when the text contained style devices like metaphors and/or analogies.

Coding frames

Because scientific press releases have not previously been analyzed on the framing of ocean plastic and ocean climate change; and to make a comparison between the two topics possible, we used an inductive framing approach [Matthes & Kohring, 2008]. In this technique, frames are not determined as a whole, but the elements that make up the frames are extracted individually from the text as independent variables. A cluster analysis subsequently groups the variables that occur systematically together throughout the various texts. These clusters of frame variables are called ‘frames’.

We defined the textual elements that built the frames, i.e. the frame variables, by semi-open coding 20% of the data set. Coding was guided by the definition of framing provided by Entman [1993], whereby all variables in the text that defined a problem, cause, moral evaluation and/or solution were noted. This resulted in a list of 22 frame variables (appendix 1) which we coded in the complete dataset.

To investigate if frame variables reflected underlying frames, a principal component analysis (PCA) was used [Semetko & Valkenburg, 2000] on both the ocean climate change and ocean plastic dataset. We used a threshold of 6% for the frame variables to be included in the PCA. The number of components was determined using Kaiser's criterium [Kaiser, 1960]. To subsequently determine the frames, only variables with critical loadings were considered [Stevens, 2002].

Intercoder reliability

All frame- and narrative variables were coded to be either present (1) or absent (0) in the press releases text. Krippendorff [2004] alpha was used to calculate the intercoder reliability, because it can be used for binary data and is particularly sensitive to coder disagreement in rare categories [Krippendorff, 2011]. The validation of the codebook was done by four coders: two who validated narrative and two who validated framing. Initially, 8 randomly selected press releases for both ocean plastic and ocean climate change were coded. Based on verbal feedback and low Krippendorff's alpha scores, the codebook was altered (for the alterations that were made, see appendix 2). Subsequently, 10% of the entire data set was coded by different coders, achieving intercoder reliability between 0.8–1.0 with Krippendorff's alpha. Values for intercoder reliability per frame- and narrative variable are shown in appendix 2.

Results

Narratives

The degree of narrativity was 1.8 on a four-point scale for both ocean climate change ($SD = 0,87$) and ocean plastic ($SD = 0,81$) datasets. Figure 2 quantifies the frequency of occurrence of all separate narrative elements present in the texts. Almost all press releases contained personalization, because almost all texts referred to the scientists who conducted research and/or named people who were affected by their scientific findings. In addition, stylistic devices were often present in the form of metaphors. In almost one third of the press releases, the emotional expressions of scientists were stated. These expressions entailed excitement over scientific findings or sadness regarding the state of the ocean. Most press releases were written according to the classical inverted pyramid style, causing dramatization to be least present.

Press releases with a negative tone highlighted problems caused by ocean climate change or ocean plastic as well as challenges encountered in mitigation. These press releases did not propose a treatment. Contrary, positive texts focused on how problems could be solved. The use of 'doom and gloom' language was indicated by a fatalistic or passionate tone. Fatalistic texts emphasized risk and danger and did not name any remedies to avert the risks discussed in the press release. Ocean plastic or ocean climate change was described as the 'biggest threat of all time' or a

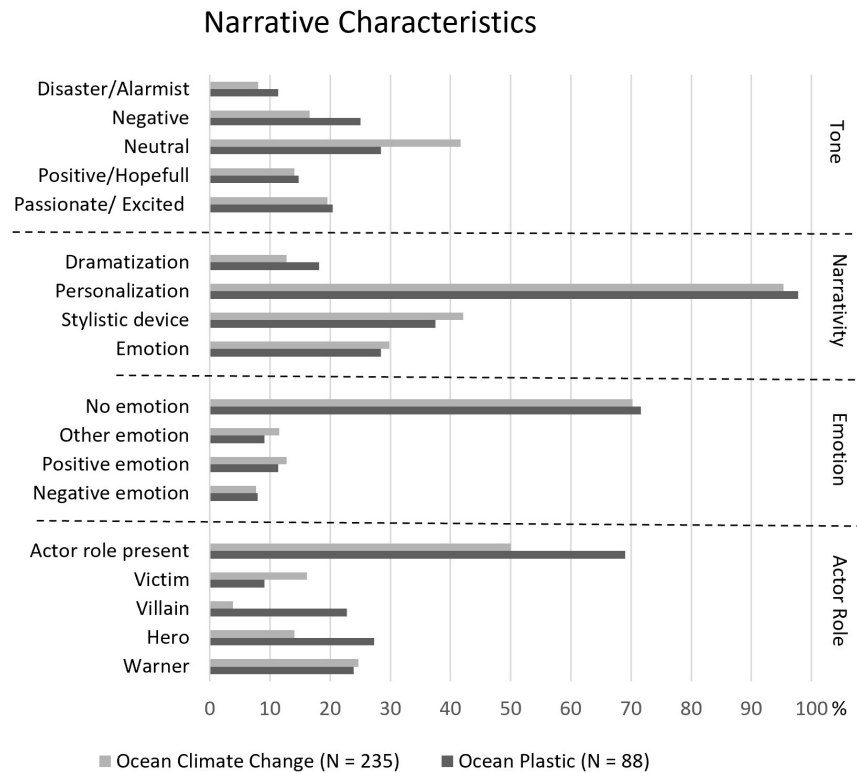


Figure 2. Percentages that narrative characteristics occurred in press releases. For the exact percentages, please see appendix 3. Emotions coded among ‘other emotion’ were most often surprise, caused by unexpected scientific findings and unexpected or rare natural phenomena.

‘climate crisis’. A passionate tone highlighted the ‘greatness’ of scientific findings, how important it is to conduct research, or how crucial it is to address ocean climate change or ocean plastic.

To further characterize the story, we looked at how many of the classical actor roles were present in the press releases’ text and if the actors were portrayed as victim, villain, hero or warner. Individual scientists or scientific organizations were always portrayed as heroes or warners. Villains were often not specified, and ‘our society’ or ‘humanity’ was held responsible for causing ocean climate change or ocean plastic. Research on ocean plastic often focused on tracing the origin of plastic to a specific region or nation, causing almost a quarter of the ocean plastic press releases to hold regions/countries specifically responsible for causing ocean plastic pollution. Industries such as fishing, tourism, agriculture or the packaging industry were almost never held responsible for ocean pollution or climate change. Victims were never individual actors, but always groups of people or organizations that were negatively affected by ocean plastic or ocean climate change.

Frames

Frame variables

Frame variables were present in differing amounts in the ocean plastic and ocean climate change press releases, as can be seen in Figure 3. The main differences were

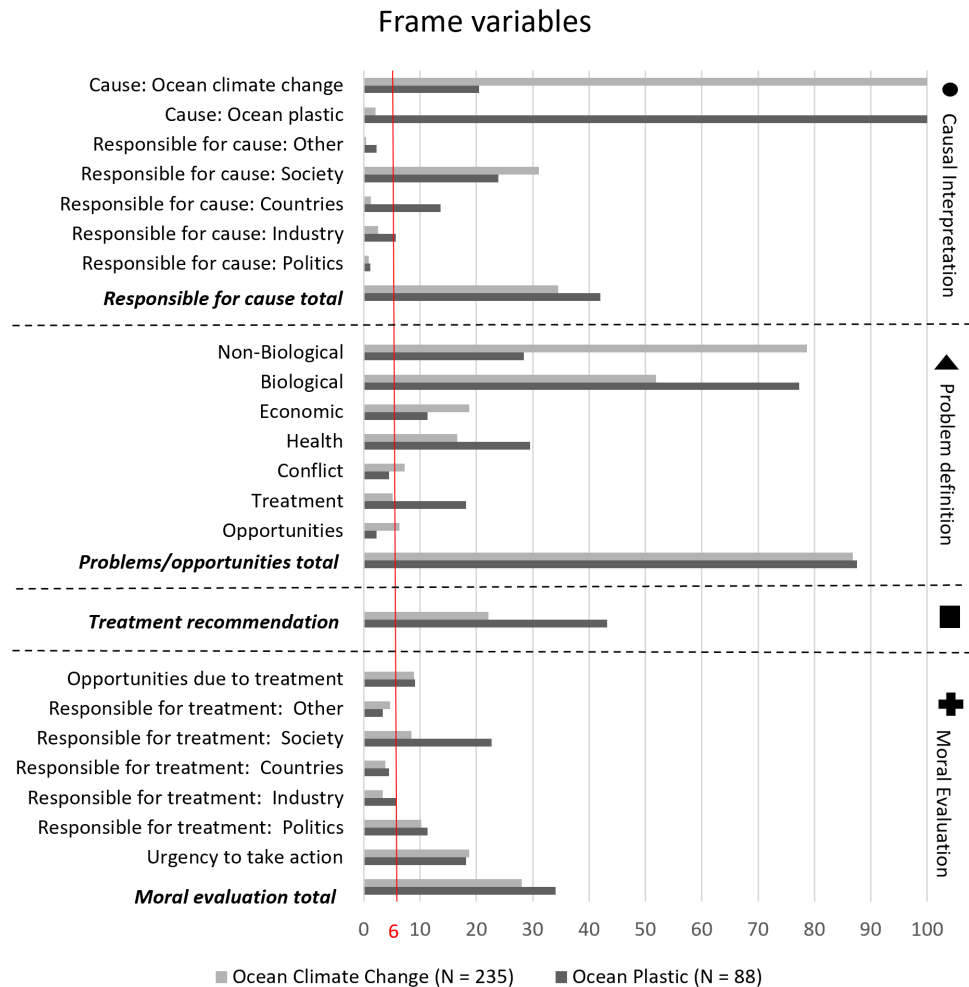


Figure 3. 22 frame variables defined the four frame elements as described by Entman [1993]. Variables belonging to the Entman frame elements are separated by dashed lines. The total that an Entman frame element was present in the press releases is indicated by the 'total' line in bold italics. The red line indicates the 6% threshold applied for inclusion in the PCA clustering analysis.

that ocean plastic press releases referred to climate change but this happened almost never the other way around. Press releases on ocean climate change focused heavily on non-biological problems, whereas ocean plastic focused more on health- and biological problems. Lastly, press releases on ocean plastic paid twice as much attention to treatment and people's responsibility to solve issues than press releases on ocean climate change did.

Frame constructs

The way frame variables co-occur affects their meaning. Although the frame variables were similar between the ocean climate change and ocean plastic datasets, the cluster analysis (PCA) showed that they occurred in different combinations. This showed that different frames were used to communicate about ocean climate change and ocean plastic research. The PCA resulted in 4 clusters of frame variables for ocean climate change (Figure 4A) and 5 for ocean plastic (Figure 4B). The results of the PCA can be viewed in detail in appendix 4.

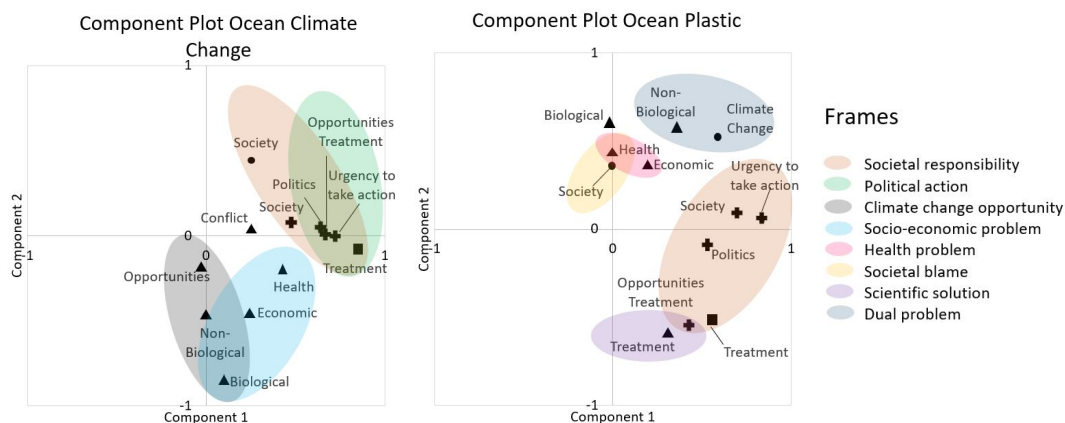


Figure 4. A) Component plot ocean climate change, showing four clusters. B) Component plot ocean plastic, showing 5 clusters. The symbols used for frame variables correspond to the Entman frame elements presented in Figure 3.

In both the ocean plastic and ocean climate change dataset, the first cluster contained frame variables focusing on society’s responsibility for causing and mitigating climate change, resulting in the **societal responsibility frame (1)**, the only frame that is present in both datasets. In the ocean climate change dataset, the second cluster contained frame variables that focused on political responsibility to mitigate climate change. Hence, this frame is called the **political action frame (2)**. Two clusters only contained frame variables related to the consequences of climate change, whereby one focused on opportunities due to climate change, the **climate change opportunity frame (3)**, and the other focused on humanitarian and economic problems, the **socio-economic problem frame (4)**.

In the ocean plastic dataset, the fifth cluster focused on health and economic problems. However, in the ocean plastic press releases the focus mainly lay on health problems, a more frequent frame variable. Hence, this cluster was called the **health problem frame (5)**. The sixth cluster focused on society’s responsibility for causing ocean plastic and was named the **societal blame frame (6)**. The health problem and societal blame frame show overlap and often co-occurred in press releases. The seventh cluster contained the frame variables: problems that occur with ocean plastic mitigation and opportunities that arise when treatment is carried out. Press releases containing these frame variables focused on scientists who solved mitigation problems and is therefore called the **scientific solution frame (7)**. The eighth cluster contained non-biological problems caused by climate change. Texts containing these variables focused on the relationship between climate change and ocean plastic, and the consequences they both have for the ocean. This cluster was called the **dual problem frame (8)**.

Frame distribution

A cross-table² was created showing the frame variables that appeared in each press release. When a press release not only stated the cause, either ocean plastic or climate change, but also identified associated problems, moral evaluations, and offered treatment recommendations, it encompassed all Entman frame elements

²The cross-table with frame variables and press releases is added to the additional online material.

and provided a comprehensive context for readers to interpret the scientific research in.

Using the cross-table, we calculated how many frame variables were present in each press release. On average, ocean climate change press releases contained fewer frame variables (4,0 SD = 2,3) compared to ocean plastic press releases (4,6 SD = 2,4). In both the ocean climate change-dataset and ocean plastic dataset, there was a large variation in the number of frame variables between press releases, as indicated by the high standard deviation. Since the frame variables define the meaning of the frame elements, we could quantify the number of Entman frame elements in each press release (Figure 5). In all press releases, climate change and ocean plastic were present as 'cause'. Hence, only the one responsible for causing these ocean issues was taken into account in the calculation. As a result, certain press releases did not incorporate any of the Entman frame elements. This absence led 52,7% of the ocean climate change press releases to have only one or fewer frame elements, in contrast to 35,2% of the ocean plastic press releases.

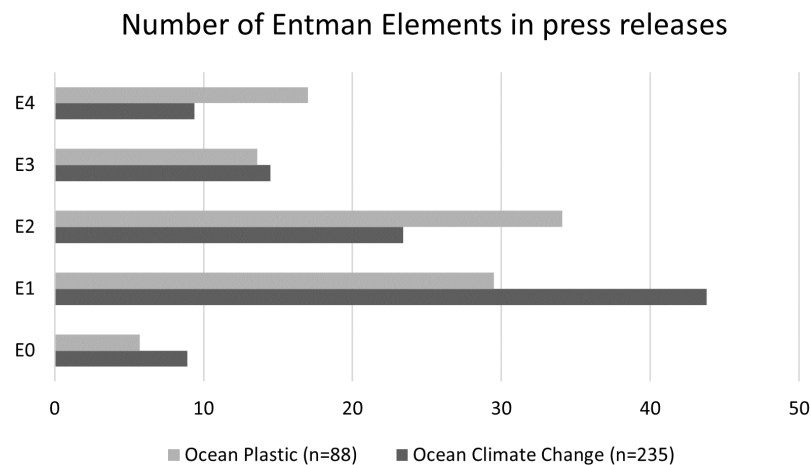


Figure 5. Bar chart showing the number of Entman frame elements present in ocean climate change and ocean plastic press releases. The figure shows that ocean plastic press releases contain on average more Entman frame elements than ocean climate change press releases do.

Because the PCA showed which clusters of frame variables make up a frame, we were able to use the crosstab to identify these frames in individual press releases. Linking the frames to individual press releases allowed us to calculate the distribution of frames within the dataset (Table 1 and 2). We only considered press releases for frame distribution calculation if the essential frame elements (either a problem, cause, treatment, and/or moral evaluation) were established by at least one frame variable. To better understand how press release authors formulated the frames, we qualitatively analyzed all press releases that contained one of the 8 frames. The qualitative analysis provided a deeper understanding of the frames and how they were communicated using narrative characteristics.

Qualitative frame explication

In the following section, we showcase the eight frames by offering a quote that is illustrative for the frame, by providing a short description of the frame and by

Table 1. Composition of frames and frame distribution in ocean climate change press releases.

Frame	No Frame	Societal responsibility	Political action	Climate change opportunity	Socio-economic problem
Solely present	62,1%	2,1%	4,7%	3,0%	19,6%
In combination		6,4%	10,2%	4,7%	26,8%

Table 2. Composition of frames and frame distribution in ocean plastic press releases.

Frame	No Frame	Societal responsibility	Health problem	Societal blame	Scientific solution	Dual problem
Solely present	35,2%	5,7%	14,8%	8,0%	4,5%	5,7%
In combination		19,3%	29,5%	23,9%	5,7%	18,2%

highlighting the narrative elements that were used in the communication of the frame. The frame descriptions stem from the qualitative analysis of press releases and offer insights into how frames and narrative elements are contextualized.

Frame 1: the societal responsibility frame

“The Antarctic has contributed very little to the production of greenhouse gases, and yet it’s one of the places on the planet receiving the most impact,” Todgham said. “I feel we have responsibility to care about the spaces that are so fragile.”^{A1}

The societal responsibility frame is the only frame present in both datasets. Societal responsibility explains how society has the power to mitigate ocean climate change and ocean plastic, a message accompanied by an urgent call to action. Emphasis is laid on the anthropogenic causes of ocean climate change and ocean plastic. There are no victims of ocean plastic, whereas victims of ocean climate change are often mentioned. Scientists warn of the threat of ocean plastic or ocean climate change if ‘we’ do not take immediate action. This emphasis is reinforced by the use of doom and gloom language, stressing the severity of problems and the urgency to address them. Scientists explain why it is important to carry out mitigation or how to solve the climate or plastic ‘crisis’. Scientists do not simply instruct readers to perform a treatment but call on them to help in the process.

Frame 2: the political action frame

“But these benefits require action and this study serves as a wakeup call to governments that they must change the way that fishing takes place or risk losing a crucial opportunity to secure our food supply for generations to come.”^{A2}

The political action frame focuses on the responsibility of politicians to solve climate change issues. The call for treatment is often accompanied by a request for immediate action. Mitigation is encouraged by emphasizing the opportunities that arise with treatment. References are made to systems threatened by climate change, for example, ‘our’ economy. Scientists warn society of the losses that ‘we’ suffer if

mitigation measures are not taken. Scientists give their opinion on the kind of measures that politicians should take. This is the only frame that portrays industries such as tourism, agriculture or fisheries as villains who contribute to climate change or overfishing. Coastal communities and countries threatened by rising sea levels, or groups of fishermen affected by shifting or declining fish populations, are portrayed as victims of climate change.

Frame 3: the climate change opportunity frame

Kaneohe Bay in Hawaii was hit hard; nearly half of its corals bleached. Hidden in the aftermath of this extreme event, however, were biochemical clues as to why some corals bleached while others were resistant, information that could help reefs better weather warming waters in the future.^{A3}

Opportunities that arise due to climate change are the central topic of these press releases, but besides opportunities, biological or nonbiological problems are always named. Texts state the positive effect climate change has on ocean life, for instance, fish species that respond favorably to warmer ocean water. Other press releases frame problematic episodes happening due to climate change as learning opportunities for researchers. The story is told in a positive or enthusiastic tone, often expressing excitement about new scientific findings. Actors overall do not fulfill particular roles. In half of the ocean climate change press releases, scientists give their opinion, which is almost always about why the topic under study is worth studying: *"Learning about these forams is very intriguing and will shed light on how early eukaryotes evolved."*^{A4}

Frame 4: the socio-economic problem frame

"Global warming is already affecting and damaging our reefs and not only harms our biosphere, but also our economy; 25% of marine fish depend on them and the losses that are occurring may be irreparable," warns Coronado Vila.^{A5}

The severity of climate change is put in a context related to society. The importance of mitigation is emphasized by describing that 'we' will suffer economic losses or that 'our' living surrounding or food supply is threatened. In some press releases, scientists and scientific organizations try to solve the socio-economic problems, placing them in a hero role. Often, scientists only warn society about the consequences of high CO₂ levels and the pace at which they are increasing. Inhabitants of coastal regions hit by sea level rise, changing weather patterns, or decreasing income caused by falling fish stock are victims of climate change. Overall, the texts are characterized by a negative or neutral tone. In some press releases, doom language emphasizes the severity of the socio-economic problems by using words such as 'crisis' or 'catastrophe'.

Frame 5: the health problem frame

Analysis reveals that such minuscule fragments can stay airborne for hours or days, spreading the potential to harm the marine environment and, by climbing up the food chain, to affect human health.^{A6}

Ocean plastic is described as problem for 'our' health or 'our' ocean. The tone of the story is overall negative or neutral. A scientist is quoted in almost every press release, but they rarely provide an opinion. When they do, the opinion emphasizes the importance of research: *This study is important, said Brahney, but it is just the beginning. Much more work is needed on this pressing problem to understand how different environments might influence the process.*^{A7} Scientists are portrayed in a hero or warner role. Industries or countries with bad waste management strategies are the villains of the story, whereas inhabitants of heavily polluted coastal areas are victims of ocean plastic.

Frame 6: the societal blame frame

"Consumer items found in everyday households are the plastics polluting our beaches and oceans. It is estimated that roughly 4.8–12.7 million tons of plastic enter the marine environment annually."^{A8}

The anthropogenic character of plastic is highlighted, emphasizing the fact that plastic used by society creates or enhances the problem of ocean pollution. The mention that 'we' created the 'plastic crisis' is enhanced through inclusive references, emphasizing how 'we' are polluting 'our' environment. Scientists describe ways to reduce ocean plastic, thereby fulfilling the hero role. Sometimes scientists warn society about the increasing amounts of ocean plastic.

Frame 7: the scientific solution frame

"Standard PET recycling today is essentially 'downcycling'," says senior author Gregg Beckham, a Senior Research Fellow at NREL. "The process we came up with is a way to 'upcycle' PET into long-lifetime, highvalue composite materials like those that would be used in car parts, wind turbine blades, surfboards, or snowboards."^{A9}

The scientific solution frame focuses on why it is difficult or challenging to reduce the amounts of ocean plastic. These problems are overcome by an 'killer idea'^{A10} of a scientist that will solve the 'plastic crisis', placing scientists in the hero role. The texts are hopeful or passionately written, emphasizing the possibilities of treatment and opportunities that arise when treatment is carried out. The use of doom language to describe problems made solutions that were offered seem better or the value of science for society seem bigger.

Frame 8: the dual problem frame

At the root of global climate change and the worldwide plastics pollution problem are two related carbon-based fuels — oil and natural gas. Not only are the two among the key drivers of climate change, they are instrumental in the manufacturing of plastics.^{A11}

The dual problem frame highlights the relationship between climate change and ocean plastic. The focus is on problems caused by ocean plastic that are amplified

by climate change. Some texts emphasize the similarities between climate change and ocean plastic, stating that both are driven by the same source, namely, oil. Other texts focus on how plastic contributes to climate warming. The tone is predominantly negative, with texts focusing on the combined negative impacts of plastic and climate change on ecosystems.

Discussion

The frames and narratives identified in this study show that press releases focused on ocean climate change and ocean plastic not only consists of abstract facts but that they involve humans, with emotions and opinions. Although the human face of science is evident in press releases, the roles occupied by actors paint a one-sided picture of science as savior of society. Victims of climate change or ocean plastic were mostly absent. When present, they were represented by specific groups or geographical regions, without a display of emotion.

Narrative elements used to communicate ocean science

We calculated a degree of narrativity to answer RQ1 and found that press releases on ocean climate change and ocean plastic both used the narrative elements personalization, emotion and stylistic devices, whereas dramatization was minimally employed. Moreover, both datasets showed a general degree of narrativity of 1.8 on a four-point scale, indicating that press officers use similar narrative writing styles for both topics. The degree of narrativity in press releases is relatively high compared to climate change news stories, which show a degree of narrativity ranging from 1.15 to 1.75, depending on the country [Lück et al., 2018]. This high degree of narrativity in press releases might be explained since almost all press releases mentioned how scientists conduct research, causing personalization to be almost always present. In addition, stylistic devices like metaphors were often used.

The results of our study are largely consistent with those of Wetts [2020], who found that the climate change discourse of organizations in press releases was largely expert-oriented and technocratic, with no attention to identification. The difference with Wetts [2020] is, however, that many scientific press releases did focus on societies' responsibility for contributing to mitigation and that scientists shared their feelings and opinions regarding ocean issues. But although the human face is evident in press releases, personalization was minimally used to highlight the social dimensions of ocean issues and was only used to personify science and represented scientists, whereby scientists were often portrayed as saviors of society. Thereby, in answer of RQ2, press releases did not emphasize the human and social dimensions of ocean issues, that are said to be needed to engage people with ocean issues and encourage pro-environmental attitudes toward the ocean [Catalano et al., 2019; Stoll-Kleemann, 2019]. We did not find many negative nor alarmist press releases, rather the balance between positive, negative, excited and neutral proofed quite even. Hence, the answer to RQ3 is that press release authors did not use a dominant tone when writing ocean science press release. It is known, however, that the media has a preference for the display of negative and alarming news stories [Harcup & O'Neill, 2017] so although the press releases do not paint a predominantly negative picture of ocean health, research in media representation is needed to evaluate whether or not press releases that focus on negative events are

taken up more frequently in the news than press releases that convey a neutral or hopeful story.

Framing ocean science in press releases versus the media

In answer of RQ4: we found 8 different frames that were used to communicate about ocean climate change and ocean plastic in press releases. Not only ocean plastic press releases emphasize the dangers, damage and adverse effects of ocean plastic; media articles analyzed in other studies [e.g. Welzenbach-Vogel et al., 2022] found the same emphasis. However, media articles focus heavily on negative outcomes, whereas our results show that the consequences of ocean plastic were often framed in relation to treatment in press releases. Similar to Schönbauer and Müller's [2021] findings, our study also found that ocean plastic was primarily framed as public responsibility, emphasizing society's role in causing problems or in addressing risks. Press releases made little attribution to the responsibility of corporations and industry. Although the research of Henderson and Green [2020] showed that media coverage of ocean plastic mainly focuses on wildlife entanglement, this was not seen in our dataset.

Bolsen and Shapiro [2018] summarized climate change frames used in U.S. media, of which the environmental consequences, national security, (political) conflict, public health, economic problem, opportunity, efficacy and science frames, are all recognized in our dataset. In contrast to the frames described by Bolsen and Shapiro [2018], the frames we found are created by the use of a clustering method, because the combination in which frame variables occur influences their meaning. So although the frames described in Bolsen and Shapiro's [2018] study were also found in our study as frame variables, their meaning is found to differ when told in combination with other frame variables. For example, solely mentioning climate opportunities in the media might suggest that action is no longer necessary [O'Neill et al., 2015]. This is an inference that does not occur in press releases because the climate opportunity is always told in combination with environmental problems. As a result, the need for mitigation is never ignored.

Many of the frame variables present in ocean plastic press releases, which are used to define the ocean plastic problem, correspond to above-mentioned climate change media frames that are used to contextualize climate change in newspaper articles. This implies that press officers use similar methods to create a context in which ocean plastic- and ocean climate change research can be interpreted. We suggest that the difference in framing between the issues of ocean plastic and ocean climate change is thus not caused by the conceptualization of frame variables, but by the frequency with which the variables occur in press releases and by the way they occur in combination with other variables.

Framing differences in relation to scientific understanding and efficacy

In our sample, press releases on ocean plastic paid twice as much attention to treatment and people's responsibility to solve issues than press releases on ocean climate change did. Climate change press release did not often state solutions but did focus on society's responsibility for causing global warming. Focusing on the role of society in either ocean pollution or climate change draws attention to the

human responsibility to combat ocean impacts and places human agency at the heart of the narrative. Earlier research showed that emphasizing society's responsibility to mitigate environmental problems, in combination with a proposed treatment, enhances people's self-efficacy [Sol Hart & Feldman, 2014]. Whereas not proposing solutions to environmental problems may lead people to feel guilty and pessimistic about their ecological future, which is a non-effective tool to motivate people to take action [O'Neill & Nicholson-Cole, 2009]. The effect of how press releases formulate human agency should be further investigated.

In press releases on ocean climate change, climate change is portrayed as standalone problem, whereas press releases on ocean plastic highlight the connection between both topics in the dual problem frame. Ford et al. [2022] suggests that, rather than debating over the relative importance of climate change or marine plastic pollution, a more productive course would be to determine the linking factors between the two and identify solutions to combat both crises. Pointing out the relationship between ocean plastic and climate change more often in ocean climate change communications could, when we follow the notion of Ford et al. [2022], potentially have a positive effect on public appreciation of these two issues. If highlighting the connectedness of ocean plastic and ocean climate change in scientific press releases enhances peoples appreciation of these ocean issues should be a topic for further analysis.

Ocean climate change press releases contained fewer frames than ocean plastic press releases. Although we found a total of 8 frames in our study, 62,1% of ocean climate change- and 35,2% of ocean plastic press releases did not fall within one of the frames, because 52,7% of the ocean climate change press releases, and 35,2% of ocean plastic press releases contained only 0–1 frame element. Hence, it could be hypothesized that due to the lack of frame variables in the ocean climate change press releases, these press releases created less context in which the research could be interpreted, making them more abstract.

Moreover, press releases on ocean climate change often stated non-biological problems like changing ocean currents or changing ocean chemistry. In addition, ocean climate change was framed as a socioeconomic problem, involving problems from multiple (scientific) domains. The abstract origin and diverse character of the problems are known to hinder people's understanding of climate change [Skanavis et al., 2019]. On the contrary, ocean plastic was mainly framed as a biological and health problem, using on average more frame variables to define the problems in press releases.

Limitations and future research

We are aware that the data set we analyzed is U.S. dominated and that the use of frames and narratives can differ per culture and country. In this study, we used both a quantitative and qualitative method to describe frames. The PCA cluster method used to define frames is limited as variables that occur infrequently but often in combination with others interfere with the analysis. Nevertheless, PCA yielded clear clusters with logical interpretations. Linking the quantitatively determined frames to individual press releases which were analyzed again qualitatively, led to a better understanding of how the frames are communicated

through frame variables and made it possible to analyze frame distribution. The calculation of frame distribution is, however, largely influenced by the inclusion criteria that are used for the analysis. Due to the strict inclusion criteria we applied, an underestimation of how often frames occur in press releases can be expected. Nevertheless, the strict inclusion criteria facilitated a clear qualitative interpretation of the frames.

We have demonstrated that ocean climate change and ocean plastic research is framed differently in press releases, whereby ocean climate change press releases name more abstract problems, use fewer frames and give fewer treatment recommendations compared to ocean plastic press releases. Future research could analyze if press releases that contain more frame variables or fewer abstract problems create a context in which the scientific study can be more easily interpreted when compared with press releases that lack this context or that use more abstract problems.

Future research could focus on the rationale behind including narrative elements in scientific press releases to increase engagement and understanding. In literature it has been argued that concrete and imaginable information is easier to comprehend and more interesting to read [Cherniak et al., 1983; Sadoski, 1999], whereby concreteness and imaginability can be reached by the incorporation of narratives [Cherniak et al., 1983; Dahlstrom, 2014]. We found that narratives differ in terms of their frequency of occurrence in scientific press releases. Experimental research could investigate the effect narrative elements in scientific press releases have on people's understanding of scientific topics, and if press releases that contain more narrative elements are easier to understand.

Lastly, it would be beneficial to also examine how frames and narratives in press releases are adopted or modified when the research is presented in the media. This will give us insights in the influence that scientific organizations have on the representation of scientists and scientific studies to wider audiences. To fully understand the process of framing happening from scientific publication to media representation, it is crucial to consider the perspectives of those who create these messages. This provides insight into best practices for science communication and sheds light on the role that science communication professionals believe press releases could and should play in making science meaningful.

This article has provided insight into the use and dissemination of frame and narrative elements in press releases and has taken an essential step to further explore the potential of frames and narratives in communicating ocean science in press releases. With the ultimate goal of creating well-designed texts that present scientific content in an understandable and engaging way.

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Authors

Aike Vonk is a Ph.D. candidate at the group of Public Engagement and Science Communication at the Freudenthal Institute at Utrecht University, the Netherlands. Her main research interest is to understand how ocean research is communicated by scientists and scientific organizations and how the communication about ocean science changes when traveling through different media.

ORCID: 0009-0004-5250-5665



a.n.vonk@uu.nl

Mark Bos is assistant professor of Public Engagement and Science Communication at the Freudenthal Institute at Utrecht University, the Netherlands. His main research interest is communication about science in the public domain. Primarily in information seeking and processing behaviors, interactivity, and in relation to visualizations and journalism.

ORCID: 0000-0002-4396-9861



m.j.w.bos@uu.nl

Ionica Smeets is professor of science communication at Leiden University, the Netherlands. Her main research interest is bridging the gap between experts and the general public. She enjoys working in interdisciplinary projects that focus on effective science communication about a specific topic, ranging from statistics to biodiversity and from hydrology to health research.

ORCID: 0000-0003-1743-9493



I.Smeets@biology.leidenuniv.nl

Erik van Sebille is professor of oceanography and public engagement at Utrecht University. He investigates how ocean science can be used for sustainable development through public engagement. After receiving his Ph.D. from Utrecht University in 2009, he worked at the University of Miami in the U.S., the University of New South Wales in Australia, and Imperial College London in the U.K. before returning to Utrecht University in 2017.

ORCID: 0000-0003-2041-0704



e.vansebille@uu.nl

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Supplementary material

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Appendix 1 — Explanation of frame variables

Appendix 2 — Validation of codebook using Krippendorff's alpha

Appendix 3 — Results narrative analysis

Appendix 4 — Results statistical analysis

Appendix 5 — List with quote references



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