Abstract

A media brew of implied, hidden and unknown risk claims: cognitive discourse analysis of public health communication

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Public health messages rely heavily on media exposure in order to reach the intended audience (which could be the general public as a whole, or a sub-group such as people with underlying health conditions). Importantly, media also play a pivotal role in communication around health science, though they are commonly criticised as being sensationalist (Shuchman and Wilkes 1997). In this chapter, we will look at media reports on the presence of minute amounts of emerging contaminants in the drinking water supply. Although the majority of scientific studies offer no evidence that these residuals present a health threat, a degree of uncertainty exists and has been exploited by many news outlets (e.g. Donn *et al.* 2008a, 2008b; Mendoza 2008a, 2008b).

Cognitive discourse analysis (CogDA) is a relatively new analytical tool, developed specifically for medical discourses (Rundblad 2007, Knapton and Rundblad 2014, Rundblad et al. 2013). Employing a functional approach as its foundation, CogDA fuses a clause level micro-analysis with cognitive linguistic approaches, notably frame semantics (Fillmore 1982) and localist semantics (Anderson 1971), which allows us to identify the conceptualisations that underlie the media stories.

Our data is a representative sample of media reports appearing nationally and locally in the UK and US press from 2006 to 2011, taken from a larger corpus (Tang and Rundblad 2015), and which reflects the time before and after the iconic Associated Press story in March 2008 on emerging contaminants as a threat to public health. To provide a comparison to media accounts, we also examined documents appearing on water industry and government websites during the same period that address the threat posed by contaminants.

The analysis revealed media portrayals to be typically simplistic and inflammatory: Contaminants are vividly portrayed as a disease that purposefully fights its way into the water supply, while the general public - both the true culprit and the victim of the contamination – is almost absent from the discourse. At the same time, the agency of the water industry and key government agencies in counteracting the threat is concealed by devices, such as the passive voice. The effect on the reader is profound confusion and the potential for unnecessary worry and unwarranted behaviour changes is high.

We will discuss strategies that allow the writer to produce a more balanced and informative account of the causes and consequences of water contaminants.

1. Introduction and context

Media reports play a crucial role in how scientific knowledge about emerging health threats is negotiated in a given sociocultural context, though they are commonly criticised as sensationalist (Shuchman and Wilkes 1997). Our study looked at the case of water contaminants known as endocrine-disrupting compounds (EDCs) and pharmaceuticals and personal care products (PPCPs) and how these are presented linguistically in the media and in texts by water industry professionals. As will be discussed in the rest of this section, the scientific evidence at the time of writing suggests the risk to public health is minimal at best, but public concern about contaminants was amplified following a flurry of media reports about their discovery. Cases such as this, where media representations of risk are imbalanced, inadequate or incomplete, can have negative consequences for public health, whether the focus is on a new medication (Moynihan 2000), an isolated and fraudulent study linking a vaccine with negative health outcomes (Smith 2008), or a limited outbreak such as Ebola in the US (Towers 2015). Based on such reporting, the public can make ill-informed judgements that can have dangerous consequences, e.g. for vulnerable sub-groups.

In this chapter, we demonstrate how an analysis of the language used both in media reports on water contaminants and the attempts of water and public health organisations to attenuate fears can lead to a richer understanding of how public perception of contaminants has been constructed; knowledge that can enhance the design of messages and risk communication about an emerging health threat. After providing some background to the study, we will outline our unique approach to linguistic analysis (Section 2). We will then present the key findings (Section 3) and discuss their implications (Sections 4 and 5). In the rest of this section, to contextualise the study and highlight the utility of linguistics as a methodological resource, we provide a sketch of the risk scenario involving contaminants (Sections 1.1 and 1.2), before outlining previous research into media representations of health threats (Section 1.3) and how the linguistic method we adopted can provide a fresh perspective (Section 1.4).

1.1 Emerging contaminants in drinking water – a potential health threat

In the UK and the US, the presence of contaminants in the drinking water supply is strictly regulated to ensure it is 'wholesome', i.e. not harmful to human health (Drinking Water Inspectorate 2009, 9). As technology advances, water and environmental researchers have been able to detect contaminants at increasingly minute levels, leading to the identification of the presence of what have been classified as endocrine-disrupting compounds (EDCs) and pharmaceuticals and personal care products (PPCPs). As these contaminants occurred at barely detectable levels, there are no regulations requiring their removal from drinking water. EDCs and PPCPs are, thus, an excellent example of an emerging health threat – one that has been freshly discovered, and whose implications are only beginning to be understood. Subject to intense scrutiny within the scientific community and the water industry, at the time of writing, the general scientific consensus is that there is no immediate risk to human health and that regulation is not necessary. Although a number of studies have associated reproductive disorders in fish with particular EDCs or PPCPs (e.g. Ramirez et al. 2007), humans exposed to the same water are unlikely to be affected due to important differences in the extent and type of exposure (Snyder et al. 2008).

Despite this consensus, the very nature of risk assessment involves a degree of uncertainty, and some findings, e.g. the links between EDCs and abnormalities in aquatic wildlife, might on the surface seem to contradict the judgement that contaminants are likely to be harmless to humans. In

the next section, we will discuss the vulnerability of scientific uncertainty to exploitation by the media.

1.2 Media reporting on emerging contaminants – a health scare

The potential of media representations of scientific evidence to have inflammatory effects, such as the amplification of risk perception, has been well documented outside of linguistics (Kasperson et al. 2003). In the case of EDCs and PPCPs, reporting in the UK and the US was sporadic until a now iconic media campaign by the Associated Press in 2008 (Donn *et al*. 2008a, 2008b; Mendoza 2008a, 2008b). These articles put a spotlight on the presence of contaminants in US drinking water, including the fact they were unregulated, and raised uncertainties about their potential harmfulness. The story was picked up with increasing intensity on both sides of the Atlantic. In the US, where the reporting was (and still is) the most intense, the suggestion that there could, in fact, be a health threat to humans led to congress level discussions about regulation.

Our case will illustrate how media portrayals of an emerging threat can construct a risk as greater than it actually is (Slovic 2000), thereby engendering levels of public concern that are, as of yet, unfounded in the scientific evidence that is the basis of reports. In this sense, media reporting on EDCs and PPCPs and its consequences for shaping public perception, is a good example of a 'health scare'. In such a scenario, the public health risk is that skewed interpretations of scientific evidence prompt behaviours that have unfavourable outcomes. For instance, during the Measles, Mumps, and Rubella (MMR) controversy in the UK, the media publicity surrounding a later-discredited journal article linking the MMR vaccine and autism saw a dramatic decrease in vaccine uptake and an increase in measles outbreaks (Smith 2008; Friederichs 2006).

It is our view that an enhanced understanding of how the media represents a particular phenomenon can provide vital insights into how attitudes, beliefs and perceptions are constructed by the public. As we shift from an expert-driven regulatory process to a more participatory process influenced by public opinion (Lofstedt 2013), such a perspective is crucial to avoiding a deficit view that assumes risk communication is a simple matter of correcting the public's subjective account of a given threat based on the objective one determined by science. There are suggestions that public engagement would be more effective if institutional preconceptions of an ignorant and obstructive public are set aside in favour of greater reflexivity on the part of policymakers and practitioners (Stilgoe 2014). Instead of imagining how they think people will respond, they are encouraged to study examples of actual attempts at communication.

As we will discuss in the next section, our interest in this study was to examine the potential of the language used to communicate about health risks and the science of contaminants to influence such interactions. The rationale is that by looking at media representations and public health messaging about a given threat, it is possible to gain a fix on how people, including vulnerable sub-groups, such as people with long-term conditions, evolve their own understandings of a situation. A deeper understanding of how particular types of language use might promote particular responses will help guide the language choices made by practitioners in messages designed to promote public health.

1.3 Studies of reporting on health concerns

A number of investigations using content analysis (e.g. Combs and Slovic 1979, Olausson 2009) or other non-linguistic methods of analysis (O'Connell and Mills 2003) have explored how media reports distort or exaggerate scientific accounts of particular threats. Recurrent findings show that

journalists either are reluctant in representing scientific uncertainty about a given threat (Olausson 2009) or they make the risk claims the focus of the controversy (Rödder and Schäfer 2010). In the latter case, the representation of the risk scenario and the representation of science is simplistic; for example, lacking examination of cause and effect (Wahlberg and Sjoberg 2000), failing to specify health outcomes and health advice (Brittle and Zint 2003), or achieved through the creation and exploitation of oppositions, such as heroes and villains and safety and danger (Seale 2003). These simplistic representations of risk consequently lead to an amplification of public concern (Barrett and Ball 2009).

One limitation for content analysis studies is their sole focus on one genre, mainly media reports. This neglects the important role of government agencies in providing information to the public to address concerns about a health threat (Timotijevic 2006). In addition, while content analysis is an excellent way of establishing what aspects of a given risk scenario are brought to the fore or backgrounded in a given type of communication, it offers less of a commentary on how this effect is achieved. In this respect, linguistics, with its focus on language as the primary mediating tool for communication, has particular utility when applied to the business of identifying foregrounding or backgrounding effects and how these are realised.

Despite this potential, there are surprisingly few linguistics studies investigating communication about health threats. Some of these have identified specific types of language that mediate unrealistic portrayals of risk. Rundblad and colleagues (2006) compared the scientific articles at the heart of the debate about the MMR vaccine with UK media reports leading the debate in the public eye. Common to both types of discourse was the potentially misleading use of terms like *may* and *might* in ways that could persuade the reader to identify the MMR vaccine as a danger, e.g. suggestions that it *might* be linked with autism. Similarly, in a study of reporting on avian flu, Nerlich and Halliday (2007) note how the frequent use of the verbs *warn*, *fear* and *threaten* in relationship to statements made by scientific authorities constructs what they refer to as a 'rhetoric of fear'.

A more recurrent focus of linguistic investigations has been on how the use of language about the outbreak of a particular disease can lead to a recontextualisation of scientific knowledge about the risks. Koteyko and colleagues' (2008) study of how the use of adjectives *basic*, *simple* and *proper* in media portrayals of the uncertainty surrounding the MRSA virus revealed two contradictory discourses: either coping with infection is simple, i.e. 'not rocket science', or MRSA is constructed as a complex matter for which 'there is no silver bullet'. Other studies have identified metaphor as a key device for recontextualising scientific knowledge within the public domain. For instance, the metaphor [FIGHTING DISEASE IS WAR] [i], which pitches key participants like the general public, scientists and the government in a battle with the disease in question, has been identified both in reporting on foot and mouth disease (Nerlich, Hamilton and Rowe 2002), and cancer (Camus 2009, Demmen et al. 2015). Authors of these studies typically raise questions about the appropriateness of particular linguistic devices in terms of whether they are used in ways that might be confusing or that provide a misleading impression of the risk scenario. For instance, the metaphors and other linguistic devices identified by Chiang and Duann (2007) in a Taiwanese and Chinese newspaper reporting on SARS represent the disease in terms of political rather than medical discourse. It is beyond the scope of such investigations to state whether particular representations translate into amplified risk perception or miscued and incomplete interpretations of the scientific evidence. However, it is our belief that analysing the linguistic features used to represent an emerging health threat in the public domain is an important step towards understanding how

people perceive and respond to such threats, and developing ways of generating effective forms of public engagement.

1.4 A cognitive linguistic approach

Our study set out to investigate the linguistic portrayal of the risks posed by EDCs and PPCPs in publicly available discourse about contaminants. Specifically, we identify how (often subtle) patterns of language foreground certain elements of the risk scenario involving contaminants, and, by the same act, background others. The main focus is on media discourse as the primary channel of communication. However, we also draw comparisons with the official accounts by water industry and government organisations (which we collectively refer to as *outreach*) designed as a response to or as a pre-emptive effort ahead of expected media representations. As will be discussed in the following section, we employ a novel form of analysis known as Cognitive Discourse Analysis (CogDa), a type of microanalysis that seeks to identify patterns in how key participants and events are construed by comparing the linguistic representations on the surface of texts with the implicit conceptualisations beneath. We will argue the utility of CogDa as a means of identifying non-obvious patterns of meaning that have important implications for the design of transparent and balanced communication about a given threat.

2. Introduction to method: Cognitive Discourse Analysis (CogDA)

CogDA draws upon the relationship between language and meaning as laid out in cognitive linguistic theory. Instances of language use are both seen to represent concepts in the mind of the speaker (or writer) and act as prompts for forming concepts in the mind of hearer (or reader) (Lakoff and Johnson 1980). By tracking the lexico-grammatical and semantic patterns in language use, CogDA seeks to find evidence for the mental conceptualisations that organise information and experience. Thus, it seeks to track and document grammatical and lexical patterns in terms of how they are applied in the text on a clause level, emphasising the effects of syntactic structure and linguistic choice. For instance, we can express the financial transaction between a buyer and seller by selecting the phrase *to hand over the cash*, rather than the equally plausible phrase *to receive the cash*. Each phrase is likely to prompt a different effect and conceptualisation of the persons involved in the action referred to (i.e. the buyer and seller), although the underlying semantic meaning is (largely) the same. CogDA's approach to the analysis of the conceptual structures underlying specific texts and their effect on the reader/hearer and the identification of the texts' surface level features is, in part, enabled through a merger of the cognitive approaches of localist semantics (Anderson 1971) and frame semantics (Fillmore 1982).

By examining the semantic roles that different participants/entities fulfil, localist semantics (Anderson, 1971) allows us to explore how they are portrayed in relation to one another. Accordingly, the components of each clause are classified based on their semantic roles, representing the semantic functions of language. The main semantic roles are listed here, and examples of how these roles are realised in a sentence can be found in Table 1 below:

Agent	The entity performing the action
Theme	The entity that is affected or structurally changed by an action

Source	The original location of the theme
Goal	The final location of the theme
Instrument	The resource used to perform the action

Table 1 Examples of clauses coded according to semantic roles and concepts

Ex	Clause	Agent	Action	Theme	Goal
1)	U.S. manufacturers…have legally released at least 271 million pounds of pharmaceuticals into waterways	INDUSTRY *U.S. manufacturers*	CONTAMINATE *have legally released*	CONTAMINANTS *at least 271 million pounds of pharmaceuticals*	WATER SUPPLY *into waterways*
2)	Drinking water is being contaminated with potentially harmful chemicals	UNKNOWN	CONTAMINATE *is being contaminated with*	CONTAMINANTS *potentially harmful chemicals*	WATER SUPPLY *drinking water*

Fillmore (1982) defines *frame* as a system of related concepts (which are in capitals here in Table 1 and throughout) that fit together within a single structure. In accordance with Rundblad (2007), we distinguish nominal frames (which contain concepts for both (living) participants and (non-living) entities and action frames (e.g. GIVE, PUT, DRINK). Furthermore, when one concept is triggered (through the use of a lexical item), it evokes the whole frame to which the concepts belong. As shown in Figures 1 and 2, frames can be represented as a hierarchy, allowing the analyst to distinguish between different levels of categorisation (in capitals) and the lexical level (in italics).

Figure 1 Example of a nominal frame

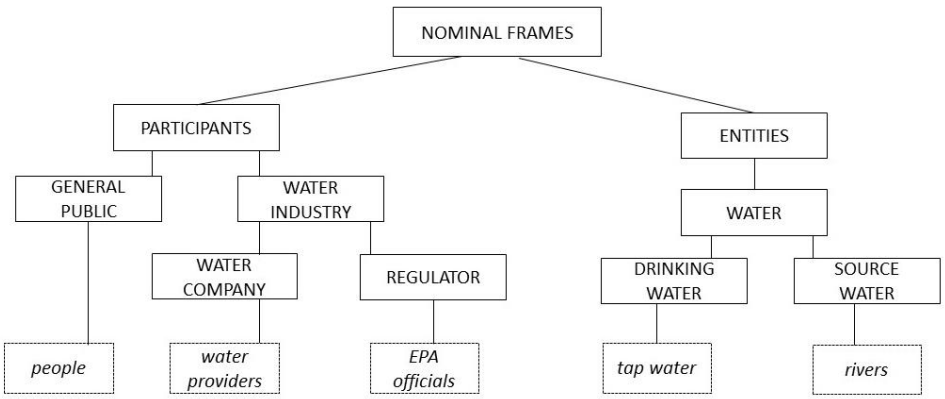
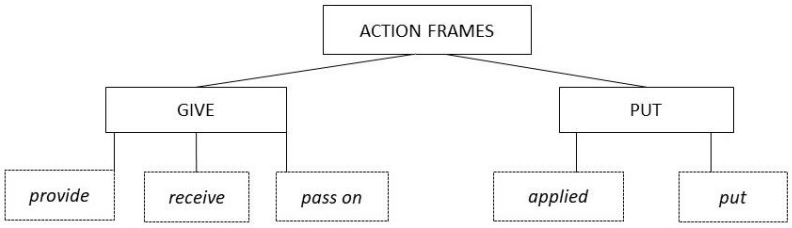


Figure 2 Example of an action frame



If we apply Fillmore's concept of a frame to the current context of reports about contaminants in the water supply, we can identify what we might call the contamination frame. This comprises three central concepts: the CONTAMINANTS themselves, the MATERIAL/ENVIRONMENT in which they are found, and the person responsible for putting them there, i.e. the CONTAMINATOR. Combining Fillmore's frames and concepts with Anderson's approach, we can assign semantic roles to each concept, so we get CONTAMINATOR as the Agent putting CONTAMINANTS (Theme) into MATERIAL/ENVIRONMENT (Goal). It should be noted that these concepts always have the same semantic roles in this frame, although syntactically, the lexical items that stand for them can be manipulated and moved around in the sentence (see examples in Table 1).

CogDA is performed on a clause level. Each element of the clause is tagged (i.e. annotated) syntactically, semantically and lexically. The precise concepts that are activated will depend on the context under investigation. Thus, for our contamination frame, we might expect the concept WATER SUPPLY to fill the role of MATERIAL/ENVIRONMENT. By tracking the frames activated and the semantic roles each concept fulfils, it is possible to track different linguistic representations of the same (or similar) semantic relationships and syntactic preferences, as the examples in Table 1 above show. By uncovering which frames occur, the semantic roles utilised and how they are linked, CogDA can provide evidence for the conceptualisations that structure the selection and presentation of information. Specifically, CogDA allows the analyst to distinguish between concepts that are explicitly present (e.g. U.S. manufacturers standing for the concept INDUSTRY in Table 1, Example 1), versus instances where no lexical item is present, but the structure of the frame suggests implied concepts (e.g. UNKNOWN in Table 1, Example 2).

Another way key entities involved in a risk scenario (e.g. the CONTAMINATOR or CONTAMINANTS) can be foregrounded and backgrounded is through the distinction between literal and non-literal uses of language. By marking instances of metaphor and metonymy**,** CogDa permits the identification of non-literal use of language and the semantic roles in which they occur. Tracking these semantic relationships over a corpus of texts enables the identification of dominant linguistic patterns and their distribution in particular discourse types.

3. A CogDA analysis of media reporting on emerging contaminants

Our study sets out to examine the language used to report the discovery of contaminants in drinking water and their risks in media reports and outreach materials (i.e. newsletters, reports, articles, etc.) posted on the websites of water industry and public health organisations in the UK and the US. The analysis seeks to identify the conceptualisations underlying the language used to articulate the risk claims made and the key actors involved. Based on an appraisal of how the use of particular linguistic devices foregrounded and backgrounded aspects of the risk scenario involving contaminants, we make inferences about the potential for the linguistic representation of scientific

information about contaminants to influence perceptions, attitudes and public knowledge. By comparing the representations in media reports with those in outreach reports, it is possible to identify patterns that are specifically media-like, and draw evaluations about the design of the communication crafted in response. In this section, we will first account for the procedures in selecting the sample (Section 3.1), before reporting on the key findings (Section 3.2).

3.1 Sample and analysis

Media and outreach reports published in the UK and the US between January 2006 and April 2011 were collected and compiled into a corpus for analysis. The reporting period, thus, accounts for the time immediately before and after the upsurge in US media interest following the 2008 Associated Press reports. This corpus totals 384 media articles (274,876 words) and 116 outreach texts (69,025 words), combining to reach a word count of 343,901. Two analyses were conducted on the data. An initial analysis, which we have accounted for elsewhere (Tang and Rundblad 2015), was a corpus linguistic investigation that used specialised software to identify broad quantitative patterns in the representation of contaminants. A second analysis is the focus of this chapter.

For this CogDA study, we selected a representative sample of 70 media texts and 22 outreach texts for analysis. For the media sample, we selected a minimum of two texts per year per country. For years with a high number of texts, we selected a higher proportion, with the maximum capped at 20. After a count for each year was established, texts were chosen at random from each category. The outreach texts were organised into categories based on country and organisation type (e.g. regulator, water company). For each category, 17% of the texts (17% was the average percentage of media texts selected for each year) were randomly selected. For both media and outreach sampling, if a chosen text was qualitatively unrepresentative, it was replaced. For this part of the sampling procedure, we drew upon the findings of the initial corpus analysis (Tang and Rundblad 2015), which provided indications of the type of language that was typical for each subcorpus as a whole.

3.2 Key findings

Following the method outlined in Section 2, we identified the most frequently occurring entities (e.g. RESEARCHERS, WATER INDUSTRY), their semantic roles (agent, theme, goal, etc.) and key actions (e.g. CONTAMINATE) in our sample texts. Although the frame compositions were largely similar in the two subcorpora, with broadly similar agents, themes, goals and actions, our use of CogDa revealed a number of qualitative differences in relation to how these underlying conceptualisations were represented in terms of lexical items and sentence constructions. Our analysis below will initially focus on these differences in terms of the language used to identify contaminants as a health threat. Section 3.2.1 will look the representation of CONTAMINANT agents in outreach texts in relation to the scientific evidence about their discovery and potential impacts. Sections 3.2.2 and 3.2.3 will examine how media language offers an alternative and more vivid portrayal of contaminants as a threat that foregrounds their agency as the cause of unsubstantiated effects, often in contradiction of the best scientific knowledge at the time. We will then focus on the representation of the human agents identified by the analysis: the people responsible for contaminants, their detection and their management (Section 3.2.4). We look at how implied agency was used in both media and outreach texts to background the accountability of the general public as contaminators and the activities of the water industry in detecting and monitoring contaminants as part of their routine operations.

3.2.1 The representation of contaminant risks in outreach texts

Outreach texts are the outputs of water utilities, regulators, public health and environmental organisations focused on raising public awareness of the risks posed by contaminants. Our clause by clause analysis of the selected texts revealed that CONTAMINANTS were the third most frequently occurring agents (see Table 2 further down). The following extract from a text posted by the Virginia Department of Health will serve to illustrate how the dominant linguistic patterns involving CONTAMINANTS as agents serve to construct an impression of the health threat they pose:

> What are 'PPCPs'?
> These are pharmaceuticals and personal care products used for personal health or cosmetic reasons or used by agricultural businesses to enhance growth or health of livestock. PPCPs include thousands of prescription and over-the-counter therapeutic drugs, veterinary drugs, fragrances, lotions and cosmetics. People contribute PPCPs to the environment when medication passes out of the body and into sewer lines, external products wash down the bath drain or when unused medication is placed in the trash.
>
> Is my water safe?
> Studies have shown that pharmaceuticals are present at extremely low levels in our water supplies. Further research suggests that certain drugs may cause ecological harm. More research is needed to determine if PPCPs have potential human health effects. To date, scientists have found no evidence of adverse human health effects from PPCPs in the environment

As we can see in this extract, CONTAMINANT agents were often associated with BEING actions (e.g. *are*, *include*, *combine*, *incorporate*) or CAUSE actions (e.g. *cause*, *make*, *pose*, *promote*) in outreach texts. In the case of BEING actions, we typically found a superordinate term for CONTAMINANTS (e.g. *PPCPs*, *pharmaceuticals and personal care products*) as the agent, followed by a list of subordinate terms, as in the following example from the extract:

3) PPCPs include thousands of prescription and over-the-counter therapeutic drugs, veterinary drugs, fragrances, lotions and cosmetics.

These associations between superordinate and subordinate terms serve as explanations for the scientific categorisations of the various contaminants detected with the new technology. We also note that these superordinate terms – either compound terms (*pharmaceuticals and personal care products*, *endocrine disrupting chemicals, contaminants of emerging concern*) or their initialisms (*PPCPs, EDCs, CECs*) – are semantically precise. That is, they assign a more specific meaning than the more frequently used terms for contaminants that could have been chosen, e.g. *contaminants* or *chemicals*. Based on these associations between superordinate and subordinate terms, what might be otherwise represented as a highly diverse array of threats are, thus, assigned unique and homogenising linguistic identities.

CAUSE actions link CONTAMINANTS in the role of agent with a reference to EFFECTS in the role of theme (the themes are highlighted in the following two examples from the extract):

4) …PPCPs have **potential human health effects**.

5) …certain drugs may cause **ecological harm**.

These conceptualisations are extremely important for risk communication as they foreground the potential harmfulness of contaminants. For instance, as well as linking CONTAMINANTS with potential EFFECTS, we can also infer the entity that is at risk, even though this is not always made explicit. The use of *human* and *health* as pre-modifiers of *effects* in Example 4 suggest that it is HUMANS who are impacted, just as the use of *ecological* in Example 5 suggests WILDLIFE as the affected entity. In both instances, we would argue that the entity at risk is implied rather than made explicit, as it is not represented nominally (i.e. *human* and *health* pre-modify the term instantiating EFFECTS). Following the localist semantics approach used in CogDA (see Section 2), we can assign HUMANS and WILDLIFE (or any other entity at risk) the role of goal of CAUSE actions. The underlying conceptualisation is, thus, that CONTAMINANTS (the agent performing the action) CAUSE (e.g. *develop*) EFFECTS (the theme changed by the action) in HUMANS or WILDLIFE (the goal and the final destination of EFFECTS). Within this pattern, in comparison with the semantically precise language used for CONTAMINANTS, the terms used to refer to EFFECTS, e.g. *effects*, *harm*, are noticeably unspecific.

While the existence of contaminants in the water supply is uncontested and quantifiable, the nature of their effects and who or what might be at risk is uncertain. This distinction is, as we have seen, reflected in the level of semantic precision of the language used.

3.2.2 The representation of contaminant risks in media texts

As mentioned in the introduction to Section 3, there were key qualitative differences in how conceptualisations of the threat posed by contaminants were represented linguistically in media and outreach texts. In the following extract from an article by the Associated Press, we find similar frames to the ones identified in the outreach extract above, including CONTAMINANTS, EFFECTS and CAUSE actions, but there are key differences in the language used to represent them:

> In tests of wastewater retrieved near other European hospitals and one in Davis County, Utah, scientists were able to link drug dumping to virulent antibiotic-resistant germs and genetic mutations that may promote cancers, according to scientific studies reviewed by the AP.
>
> Researchers have focused on cell-poisoning anticancer drugs and fluoroquinolone class antibiotics, like anthrax fighter ciprofloxacin.
>
> At the University of Rouen Medical Center in France, 31 of 38 wastewater samples showed the ability to mutate genes. A Swiss study of hospital wastewater suggested that fluoroquinolone antibiotics also can disfigure bacterial DNA, raising the question of whether such drug concoctions can heighten the risk of cancer in humans.
>
> Pharmacist Boris Jolibois, one of the French researchers at Compiegne Medical Center, believes hospitals should act quickly, even before the effects are well understood. 'Something should be done now,' he said. 'It's just common sense.'

(Associated Press, April 2008)

Just as in outreach texts, the harmfulness of contaminants is communicated through the nominal frames associated with CAUSE actions. For instance, in the following example, CONTAMINANTS (agent) CAUSE the EFFECTS (theme – highlighted in the following examples) in HUMANS (goal):

6) …such drug concoctions can heighten **the risk of cancer** in humans.

A key difference is that we find a more specific term for EFFECTS than in the outreach extract (*risk of cancer* compared to *potential human health effects*). This is also the case for other EFFECTS terms, both in the media extract above, e.g. *virulent antibiotic-resistant germs* and *genetic mutations*, and elsewhere in the media corpus, e.g.

7) Atrazine has caused **a hormonal imbalance**. (UK media)

8) The chemical had been shown to…make frogs develop **both male and female features**. (UK media)

As in the outreach sample, the harmfulness of contaminants is also communicated through the association of EFFECTS with the entity threatened by them (as the goal of the action). In media, however, as well as implicit goals of CAUSE actions (Example 7), there was also a tendency for explicit ones, e.g. *humans* in Example 6 and *frogs* in Example 8. These associations were also expressed through another action frame – HARM/THREATEN, which rarely occurred in our outreach sample. HARM/THREATEN actions (highlighted in the following examples) link CONTAMINANTS in the role of agent with either HUMANS or WILDLIFE in the role of theme:

9) …a mixture of drugs **could be harmful** to foetuses. (UK media)

10) Oestrogens from sewage works have been shown **to alter** the sex of river fish. (UK media)

11) …medicines for depression and epilepsy that **can damage** the brain. (US media)

In media texts, therefore, the overriding tendency is for a heightened specificity when it comes to expressing the potential harmfulness of contaminants, whether through the use of more semantically precise terms for EFFECTS or through a greater level of explicitness in linking CONTAMINANTS with HUMANS and WILDLIFE.

There was some use of precise, i.e. subordinate, CONTAMINANT terms referring to a particular (type of) EDC or PPCP, e.g. *fluoroquinolone class antibiotics*; *the anthrax fighter ciprofloxacin* in the Associated Press extract. However, more importantly, the semantically precise superordinate terms for CONTAMINANTS identified in outreach, such as *PPCPs*, did not occur here. Instead, when referring to CONTAMINANTS as a collective, we found terms like *drugs*, *chemicals* and *compounds*, which are less precise. Thus, in contrast to outreach representations, media texts point to a manifold and uncategorised threat.

The scientific uncertainty about the likelihood of effects of contaminants manifesting was expressed in various, often subtle ways in the sample of media texts. Firstly, and most obviously, a fair proportion (29.5% (84/285)) of clauses with a CONTAMINANT agent and HARM/THREATEN or CAUSE actions included terms that communicate evaluations of certainty, e.g. the modal verbs *can*,

could or *may* (as in Examples 9 and 11 above) and adverbs like *apparently* and *potentially*. As in Examples 9 and 11, these expressions construed the negative outcomes of contamination as possibilities rather than certainties. Similarly, the contingent nature of the contaminant threat was sometimes signalled by attributing relevant statements (highlighted in Example 12) to a particular authority:

12) 'Our research shows **that a much wider range of chemicals than we previously thought is leading to hormone disruption in fish**,' says Professor Charles Tyler at the University of Exeter, one of the paper's authors. (UK Media)

We would argue that neither device – either citing authorities or utilising modals/adverbs – offers a strong and consistent message about the scientific uncertainty surrounding the potential for contaminants to affect public health. The association of statements about contaminant effects with different authorities meant that contradictory claims about the risks could often be found in the same text (see Tang and Rundblad 2015 for a closer analysis of these patterns). In addition, modals like *may* and *might* and adverbs like *perhaps* are vague about the degree of (un-)certainty they attribute to a given action, thereby leaving open a wide range of possible interpretations. In the case of EDCs and PPCPs, it is important to make a distinction between the levels of scientific uncertainty for effects on humans compared to effects on aquatic wildlife (see Section 1.1). This distinction was often made in outreach texts through the use of the use of the phrase *no evidence* when referring to EFFECTS linked with humans:

13) …scientists have found **no evidence** of adverse human health effects from PPCPs in the environment. (US Outreach)

In our media sample, however, we could only detect a subtle linguistic distinction between the two possibilities based on the varying levels of specificity in terms of the language used to represent the (potential) effects of contaminants. As discussed above, CAUSE actions linked a CONTAMINANT agent with an EFFECTS theme and HUMANS or WILDIFE as the goal. When there was a HUMAN goal as opposed to a WILDLIFE goal, the exact nature of the EFFECTS was generally unspecified (highlighted in the following examples):

14) …medications may pose **a unique danger**. (US media)

15) Medications disposed down the drain pose **a health risk** to humans and the environment. (US media)

As these examples show, whoever is at risk (the goal of CAUSE actions) is often implicit. Thus, the door is again left open to a wider range of interpretations, for instance to the suggestion that, in contradiction of the scientific evidence, documented effects in aquatic wildlife (e.g. hormone disruption, mutation or feminisation (see Examples 7, 8 and 10 above) will be replicated in humans.

So far, our comparison of the language used to represent CONTAMINANT agents suggests that while the language used in outreach texts is largely sensitive to the different levels of scientific uncertainty, media language tends to represent contaminants as a more immediate and likely threat

to humans than they actually are, mainly by altering the patterns of certainty associated with different semantic roles.

In addition to the features of media language already described, we also identified metaphoric language in clauses involving references to CONTAMINANTS, e.g. the use of the term *concoctions* in the phrase *such drug concoctions* in the Associated Press extract. As we will discuss in the next section, several of these metaphors were characteristic of and integral to media representations of the risk scenario.

3.2.3 Metaphors in media and outreach texts

The tagging of the metaphoric language used for nominal frames (e.g. CONTAMINANTS) enabled the identification of metaphors according to their semantic role. Metaphors occurred as agents, themes and as the action frames in both media and outreach texts. There were qualitative similarities and differences in terms of the types of metaphor detected, with several metaphors only identified in media texts.

One type of metaphor only found in media texts drew on a FOOD/DRINK frame. This occurred when there was a need to refer to the broad range of contaminants as a collective. In such instances, we sometimes saw journalists drawing upon a term used for an unspecified quantity of food or drink containing a mixture of (unknown) ingredients (highlighted in bold below), e.g.

16) …a whole **cocktail** of chemicals acting in combination is likely to be behind the problem. (UK media)

17) Nor do you have to see a doctor to imbibe a witch's **brew** of prescriptions like pain pills, antibiotics and psychiatric, cholesterol, asthma, epilepsy and heart meds in your drinking water, says the AP. (US media)

We found the metaphoric term typically occurring as either the agent (Example 16) or the theme (Example 17). In Example 16, the metaphoric term (*cocktail*) occurs within the noun phrase instantiating CONTAMINANTS, in this case as the agent of the causal verb *acting*. In Example 17, the GENERAL PUBLIC (implied agent) is construed as drinking (*imbibe*) CONTAMINANTS (theme – instantiated by the metaphoric *witch's brew*).

The FOOD/DRINK frame was also sometimes picked up as part of the verb phrase, i.e. the action:

18) Rivers were **choking** on industrial sludge… (US media)

19) …the kinds of exposure to river pollution a human could face is very different from what a fish experiences **swimming** in a soup of 100,000 chemicals contained within effluent discharges. (US media)

As in the first two examples, CONTAMINANTS were associated with verbs that either refer to (potential) exposure or their capacity to cause harm. CONTAMINANTS (*industrial sludge*) are construed as 'harming' (*choking*) RIVERS in Example 18, and, in Example 19, an unknown agent 'exposes' (*swimming*) WILDLIFE (*fish* as an ellipted theme) to CONTAMINANTS (goal). The conceptualisation evoked by the metaphor [CONTAMINANTS ARE FOOD/DRINK] involves a jarring and vivid juxtaposition of the everyday FOOD/DRINK onto the abnormal CONTAMINANTS. As this

metaphor was only found in the media texts, the potential for consuming contaminated water was, thus, charged with a vivid and confusing negativity, not present in outreach communication.

In media reports written in the US, where the issue about contaminants has become more politicised, we found metaphors that construed the agent as violent, aggressive or invasive:

20) He said the EPA has launched a four-pronged approach…But none of those goals has any regulatory **firepower**. (US media)

21) Of course, the degree to which the triclosan **invasion** is harmful is subject to debate. (US media)

22) Some drugs, including widely used cholesterol fighters…**resist** modern drinking water and wastewater treatment processes. (US media)

In these instances, we find that contaminants are personified as living entities that wilfully pose a threat to human health. Personification co-occurred with another metaphor, namely [FIGHTING CONTAMINATION IS WAR]. In Example 20, it is the members of the US water regulator the EPA who are conceptualised in terms of their capacity to fight contamination (*firepower*). In contrast, in Examples 21 and 22, we find CONTAMINANTS in the role of a violent, fighting agent, as evoked by the terms *invasion* (Example 21) and *resist* (Example 22).

A related metaphor, [FIGHTING DISEASE IS WAR], also occurred in the media corpus; for instance, in Example 22, the use of the term *fighters* in *cholesterol fighters* construes the contaminating drugs as fighting a second war, as the original purpose of the drugs was to fight high cholesterol and related diseases. As outlined early on in this chapter (Section 1.3), the metaphor [FIGHTING DISEASE IS WAR] is commonly employed in media reports on infectious diseases. We would argue that this type of metaphoric language in media texts served to create a more vivid impression of contaminants as a potential threat.

Other types of metaphor – the only types present in outreach texts – appeared to have a different kind of effect. CONTAMINANTS were also personified in statements about the act of spreading contamination further:

23) Millions of pounds of waste drugs also **escape** into waterways from hospitals, drug plants and other factories, farms and the drains of American homes… (US media)

24) …drug residues…**slip through** sewage treatment plants. (UK media)

25) …trace amounts of these chemicals **make it through** the sewage treatment facilities and out into the environment. (US outreach)

In these personification metaphors, the CONTAMINANT agent is construed as a living agent with intentional actions. Examples 24 and 25 also illustrate how personification metaphors often co-occurred with the conceptualisation of CONTAMINANTS as being 'on a journey'. In these, the CONTAMINANTS are the agents of a MOVEMENT action, either they are escaping their usual place, e.g. hospitals or factories (Example 23), or evading the measures put in place to keep them contained (Examples 24 and 25). In these [CONTAMINATION IS A JOURNEY] metaphors, contamination is conceptualised as a path, with personified CONTAMINANT agents travelling from an unspecified origin to their final destination in the WATER SUPPLY, which occurs as the purposeful

goal of the MOVEMENT action. In Examples 26 and 27, they are furthermore conceptualised as directing their own path into the water supply (*finding*/*winding their way*):

26) They typically **find their way into source** waters via sewage outflows. (US outreach)

27) Trace amounts of the prescriptions we take and the steroids we inject into cattle are **winding their way** into our water supply. (US media)

For any health risk, any role played by human agents is central to understanding how individuals and groups have contributed to the risk scenario and in determining the public health response. Yet in media texts in particular but to a limited extent also in outreach texts, the use of these metaphors serves to background the roles of the general public and other polluters. With those truly responsible so well hidden, the reader is left with little but mysteriously occurring and resisting CONTAMINANTS.

In the next section, we will explore other ways in which the role of human agents were made less visible in our corpus.

3.2.4 The role of implied agency in media and outreach texts

In any given risk scenario, there is an important role for human actors – for instance those who have contributed to the threat and those charged with taking action to mitigate its effects. This tendency is reflected in the fact that, in both media and outreach texts, with the exception of CONTAMINANTS, the most frequently occurring agents were different types of human participants. As Table 2 shows, there was a prominent role for RESEARCHERS (scientists and academics), WATER INDUSTRY (water professionals belonging to both regulators, e.g. the Environmental Protection Agency, water utilities and other related organisations), GOVERNMENT (representatives of government agencies and politicians), the GENERAL PUBLIC, and INDUSTRY. In addition to these categories, a sizable proportion of agents could not be identified from the context (listed as UNKNOWN in Table 2).

Previous CogDA studies (Rundblad 2007, Knapton and Rundblad 2014) have shown how agents can be removed from the structure of a clause through devices like the passive voice. For instance, in the phrase *drinking water is being contaminated*, we have to infer the agent responsible for the act of contaminating. Whether the agent tended to be implied, rather than explicitly stated, depended on the corpus (media compared with outreach), with a greater tendency for implied agents in outreach texts (43.2% (630/1459)) than in media texts (33.2% 1805/5431).

Table 2 The seven most frequently occurring agents

Agent	Media (N=5431)		Outreach (N=1459)	
	n	%	n	%
RESEARCHERS	989	18.2	233	16.0
WATER INDUSTRY	937	17.3	355	24.3
CONTAMINANTS	778	14.3	174	11.9
GOVERNMENT	683	12.6	216	14.8

Agent	Media (N=5431)		Outreach (N=1459)	
	n	%	n	%
INDUSTRY	495	9.1	59	4.0
GENERAL PUBLIC	426	7.8	174	11.9
UNKNOWN	325	6.0	80	5.5

Looking across both subcorpora we notice that implied agency tends to be more common for certain actions, specifically those referring to processes that explain the occurrence and discovery of contaminants. Two of the most frequently occurring actions were CONTAMINATE and DISPOSE actions. Underlying CONTAMINATE actions was a conceptualisation whereby somebody (the agent) CONTAMINATES the WATER SUPPLY (goal) with CONTAMINANTS (theme), e.g.

28) …there are unwanted chemicals in the water supply… (US media)

29) …industrial and domestic effluents may contain compounds of both natural and synthetic origin… (US outreach)

30) Rivers, lakes and wells throughout North America, Europe and East Asia are already contaminated by a range of pharmaceutical drugs. (US media)

DISPOSE actions were conceptually similar; i.e. someone putting CONTAMINANTS somewhere, but, instead of the WATER SUPPLY, we have a CHANNEL (e.g. *sewers*, *drains*) as goal, e.g.

31) COSMETICS and medicines flushed down drains… (UK media)

There was an equally high rate of implied agents for CONTAMINATE and DISPOSE actions in outreach (85.6% (89/104)) and media texts (83.2% (282/339)). As the above examples illustrate, a dominant tendency is for the agent – the participant responsible for the contamination – to be omitted, e.g. through the use of a dummy subject (e.g. *there* in Example 28), or through the use of the passive voice to facilitate the positioning of the theme (Example 31) or goal (Example 30) as the grammatical subject of a sentence. While it is still possible to infer that human agents are responsible, their exact identity is often unclear (coded as UNKNOWN). For instance, in outreach and media texts where the emphasis is on linking pharmaceutical consumption with the presence of particular contaminants, or from the use of terms like *domestic* (Example 29) and *flushed* and *drains* (Example 31), we can infer the GENERAL PUBLIC as the implied agent, but, in other cases (e.g. Example 28), the agent's identity can only be guessed at. There is, thus, a similar effect to metaphoric language (see Section 3.2.3) in terms of the spotlight becoming firmly fixated on the presence of contaminants in the water supply as the product of contamination, with those responsible on the peripheries. As the agent has to be inferred and in particular when it is unknown, there is a broad scope for interpreting whose actions are contributing to the presence of contaminants.

Implied agents were also unusually common for DISCOVER actions. DISCOVER actions were represented by verbs referring to research actions taken in order to detect, analyse and monitor water contaminants (e.g. *searches*, *determines*, *measures*, *discovers*, *observes*). In outreach texts

overall, the role of water industry professionals was vital, with WATER INDUSTRY the most frequently occurring agent (see Table 2). Even so, the visibility of the water industry professionals involved in taking research actions was typically reduced in outreach texts, with over half of all WATER INDUSTRY agents of DISCOVER actions (56.5% (160/283)) not made explicit, e.g.

32) As analytical methods improve, many compounds such as those listed above are being found at extremely low levels… (US outreach)

A similar proportion of DISCOVER action agents (52.5% (201/383)) were implied in the media subcorpus. A key difference in media texts was that WATER INDUSTRY participants could only be identified as the (explicit or implicit) agents for only 24.5% (94/383) of DISCOVER actions with CONTAMINANTS as the theme. This was a surprising finding considering that water utilities and regulators, as part of their routine function of monitoring the water supply, were responsible for many of the discoveries reported on by journalists. Instead of references to WATER INDUSTRY participants, we found that the most frequently occurring agent was RESEARCHERS (67.4% (220/383)). This category covers both references to specific researchers, i.e. those affiliated with particular organisations and projects, as well as unspecified ones, e.g. the generic use of the terms *scientists* or *experts*.

In media texts, RESEARCHERS were typically implicit as part of a passive constructions (66.4% (146/220)), e.g.

33) …an array of pharmaceuticals **has been found** in the drinking-water supplies of at least 41 million Americans. (US media)

34) All elements in water, particulate matter and contaminants **are normally measured** in parts per million or billion. (US media)

35) The compounds **were found** in extremely minute amounts… (US media)

36) BPA **has not been proven** to cause harm… (UK media)

While we can infer that DISCOVER actions (highlighted in the above examples) were carried out by professional researchers, their exact identity and affiliation is often difficult to infer from the context. Although there is nothing that directly suggests so in the wider context of the above examples, there are some cases (e.g. in Examples 33 and 34) where we might infer that it is in fact members of the water industry who are 'discovering'. As this is not made explicit, however, the inference requires some prior knowledge of the water industry's role and responsibilities. Thus, instead of the water industry being credited with advances in technology allowing detection at previously imperceptible levels (see Section 1.1), readers might infer that it is the water industry, either through false action or inaction, who are culpable for the presence of contaminants. In this way, in media texts, the routine actions of water industry professionals in detecting and analysing contaminants are made indistinguishable from the activities of generic science.

Although WATER INDUSTRY agents were more easily distinguishable in outreach texts, the tendency for implied agency in relation to the actions of contaminators and members of the water industry was surprising. For one, downlighting the role of water industry professionals in reducing risk has the potential to undermine trust in regulators and water utilities. In addition, by their very

design, outreach texts are attempts to engage the public with information about the risk scenario that includes both causes and culprits, as well as the actions taken by members of the water organisations, in response to contamination as a threat. A possible explanation for the pattern may relate to the fact that they are written by water industry insiders used to communicating about contaminants in a register geared to a specialist audience. Outreach texts not only showed a greater tendency for implied agents than media texts (as detailed at the start of this section), but also for linguistic devices that facilitate the removal of an agent from a clause, such as the passive voice. Linguistically then, the outreach sample has much in common with scientific discourse, where human entities including the researcher can often be removed from the text entirely, as it is assumed specialist knowledge is shared amongst its participants and that implicit entities can be readily inferred (Halliday 1989, Rundblad 2007). However, as a lay reader is unlikely to draw upon such knowledge, if prompted to seek out more information by the inflammatory accounts in the mass media, they would also not be able to infer the hidden or missing aspects in media accounts from water industry texts.

Our analysis has uncovered a range of linguistic differences and commonalities in relation to media and outreach representations of contaminants as a health threat that may have the potential to promote different or incomplete understandings of the existing scientific knowledge. In the next section, we will identify the ways in which these findings might inform the practice of those working as medical and public health communicators.

4. Implications for healthcare practice

From our analysis of media and outreach communication about EDCs and PPCPs, we can identify three broad areas of language that are worth considering when communicating about health risks with a lay audience. The first relates to the degree to which the key entities in given risk scenario are made explicit in the language used to communicate about it. The key utility of CogDA lay in its capacity to identify the latent meanings concealed beneath texts as well as the linguistic devices used to achieve this effect. As shown by the analysis, these devices – e.g. the passive voice and implied agency – can mean key information needs to be inferred or is withheld entirely. The more the reader is forced to infer information, such as the likelihood of contaminant effects impacting HUMANS or WILDLIFE, the greater the chance of miscommunication, as the door is left open to a wider range of interpretations. As shown in our analysis of CONTAMINATE and DISCOVER actions in outreach texts, those used to communicating within professional groups, like exponents of scientific (and indeed medical) discourse in closed speech communities, may be at particular risk of unintentionally backgrounding information they assume to be shared knowledge, but which the lay public may not have access to. Our general recommendation in this regard would to be to ensure key messages are maximally explicit about the key entities involved and their semantic roles. For instance, the clause ‘PPCPs are present in some of our rivers, lakes and streams’ essentially represents the act of contaminating, but key entities, such as the contaminator, are implicit. In the interest of raising public awareness about PPCPs, we might rephrase this information as follows:

> Many people have expired and unwanted medicines at home, **which they then flush into the sewer system via sinks, showers or toilets**. So, by putting them in the toilet, they are effectively putting them in our rivers, lakes and streams.

In the rephrased version, the highlighted clause includes the agent as the grammatical subject (*they*) alongside a reference to both a contamination channel in the role of instrument (*via sinks, showers or toilets*) and the *sewer system* as the goal (*into the sewer system*).

Another area relates to the use of non-literal language. The metaphors detected in the sample of media and outreach texts highlighted their powerful role in conceptualising and, thus, communicating about health threats. The heavy use of personification and the (often co-occurring) use of the metaphors [CONTAMINANTS ARE FOOD/DRINK] and [FIGHTING CONTAMINATION IS WAR] in media texts enhanced the highly vivid portrayal of contaminants as a health threat. As discussed in Section 1.3, War metaphors have also been identified in the language used in a range of health contexts, indicating that they may be fundamental to how we conceptualise public health threats. In addition, the combination of personification and the [CONTAMINATION IS A JOURNEY] metaphor in both media and outreach texts served to background some of the key actors in the risk scenario. The suggestion from cognitive linguistics is that metaphor use is the product of a largely unconscious system (Lakoff and Johnson 1980), which means the widespread identification of metaphor as a key framing device in a health context (see Section 1.3.) may not always be intentional. In light of this, we would encourage reflexivity amongst health practitioners in terms of their use of metaphoric language to develop awareness of the consequences that different metaphors have and which to translate into messages that offer a more balanced and informative account of a given risk scenario.

Finally, our analysis also detected a range of linguistic patterns that distinguished different levels of (scientific) uncertainty about a health threat. One way in which the uncertainty about the potential risk to humans was communicated was in the semantic precision of the language used to refer to EFFECTS. In outreach texts, terms were generally less precise, whereas in media text terms often specified particular effects (e.g. *cancer*), which suggested a more concrete and immediate threat. We also pointed out the potentially misleading use of words like *can*, *may* and *apparently* with HARM/THREATEN and CAUSE actions in media texts, in comparison to statements about there being *no evidence* of effects on humans in outreach texts. The implication of these findings is that it is imperative to tailor language to ensure a clear and consistent evaluation of the circumstances in which a given health impact (e.g. symptoms, morbidity, etc.) is likely to manifest. As any conventional health threat, however impactful, will not affect everyone or everything that could potentially be affected in the same way, it is also imperative to use language that explicitly and clearly identifies the possibilities for different entities at risk, distinguishing, for example, between the risks to a particular species of wildlife, humans generally or people with particular health conditions.

Although each of these areas is worthy of consideration individually, it is the interaction between levels of explicitness, the use of metaphor and the language used to refer to uncertainty that has the greatest potential to influence the uptake of information. In our case, it was the combination of a vivid portrayal of the potential health impacts through metaphoric and semantically precise language, a vagueness about the level of scientific uncertainty and the backgrounding of key information that contributed to the media's over-simplistic and (judging by the public response) inflammatory portrayal of the risk scenario involving contaminants. While our study was conducted with public health communication about contaminants in mind, these findings have equal import on the more micro level, e.g. in interactions between health care professionals and patients about the pathology of a given medical condition.

5. Conclusions

The use of CogDA identified key relationships between the language used to represent the risk scenario involving contaminants in water and its underlying conceptualisations. The findings largely support the suggestions in risk research that the media can play a role in influencing the public's understanding of an emerging health risk (Kasperson et al. 2003, Frewer, Miles and Marsh 2002). In extension to these studies, linguistic analysis provided insights into how the use of linguistic devices can influence the potential interpretation and uptake of key messages. It follows that the design of communication as a response to these portrayals in the interest of public health could benefit significantly from linguistic insights. In this regard, CogDa has considerable utility in gaining access to how the conceptualisations implicit in the linguistic representation of a particular risk scenario relates to the explicit use of language.

We must, however, be wary of overstating or predicting the influence of texts on people's understanding of risk based on text analysis alone. Investigations of the public response during health crises (Rubin et al. 2009, Rundblad, Knapton and Hunter 2010) provide an empirical account of how pre-established cultural values, beliefs and perceptions also act as an interpretative filter for incoming information (Bickerstaff 2004, Dake 1992). It is, therefore, important to also take into account how the process of deriving meaning from textual features is influenced by culturally driven assumptions about its pretextual and contextual relations (Widdowson 2004). These considerations point to the utility of developing interdisciplinary insights into risk communication by drawing upon other social science approaches, e.g. the study of risk perception (Slovic 1987), alongside linguistics.

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[i] We use capital letters here and throughout to distinguish frames as the conceptualisations underlying particular uses of language, e.g. *consume*/*eat*/*have* (+ food) could all instantiate the action frame EAT. We use square brackets to denote metaphors, which involve the association between two different frames, in this case DISEASE and WAR.