The semantics and pragmatics of water notices and the impact on public health

Gabriella Rundblad

ABSTRACT

In communicating health risks to the public, it is essential that the message delivered is not misunderstood, as this can lead to risk behaviour. There has been much interest in risk communication and trust, but here we take this further by a cognitive and linguistic analysis of the intended and understood meanings of core words in drinking-water incidents. Based on a questionnaire study of 107 undergraduate UK students using the example of a 'do not drink' notice, we found that, although the majority (87.9%) would buy and drink bottled water, as many as 44% would still drink the polluted tapwater. Males and females would generally behave similarly; however, significantly more men would drink water straight from the tap. All in all, 78% of the population – males in particular – could potentially be at risk. We trace the risk behaviour to a misinterpretation of the words *drink* and *not*. Public health protection is generally perceived as the choosing of what is safe behaviour and informing the public of appropriate actions in the event of a crisis: however, communicators need to also address the words used to make up risk messages and the prior beliefs that they invoke.

Key words | hypothetical scenarios, notification, pragmatics, public health, risk communication, semantics

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INTRODUCTION

Typically, messages in risk communication are considered to contain four components: message, source, transmitter and receiver (e.g. Renn 1991). While other studies have focused on the influence that the latter three can have on public perception of risk (e.g. Griffin *et al.* 1998; Griffin & Dunwoody 2000; Hunter & Syed 2001; Doria *et al.* 2006; see also Slovic 1987), we will focus on the important role that the message plays in risk communication and specifically in controlling risk behaviour.

Although one could draw analogies between messages and parcels, a message is not an information package containing a specific content. The mental representations model we will work with here argues that messages contain several different components as depicted in Figure 1, from the receiver's perspective.

Figure 1 illustrates how mental representations, which form the content of the message, arise from language, both directly and indirectly. The direct language component constitutes the words and their meanings, and the indirect language component triggers the recipient to recall prior knowledge and beliefs which, in turn, form the context for the mental representations (on background knowledge and comprehension, see Kintsch (1998)). It is these mental representations that guide risk perception and ultimately behaviour.

Risk perception has been found to influence risk behaviours; for example, asbestos workers whose risk perception is poor are more likely to use a power tool rather than a manual method when removing material containing asbestos (Stewart-Taylor & Cherrie 1998). We know that

doi: 10.2166/wh.2008.130

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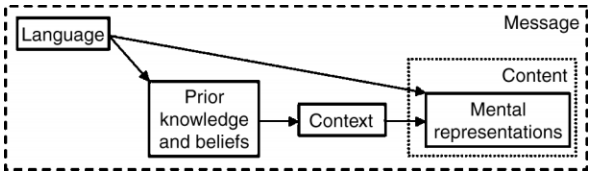

Figure 1 | The role of language, prior knowledge and context in mental representation formation.

risk perception is, to a large extent, based on prior knowledge and beliefs. However, words and their meanings can also cause people to behave in a certain risky way. Whorf (1941) described how workers tended to be very careful around full gasoline drums, but were no strangers to smoking or tossing cigarette stubs around empty gasoline drums; their behaviour was based on the belief that empty drums are not dangerous, when in fact emptied petrol drums can still contain volatile fumes. This type of risk behaviour has lead to the Health & Safety Executive's (2006) *Carrying Dangerous Goods: Common Problems* in the UK highlighting that the term *empty* 'is not a clear concept' for gases and that problems are known to occur.

It has recently been argued that risk communication studies move beyond classical approaches and come to integrate with cognitive theory (Keselman *et al.* 2005), in order to address the fact that uninformed prior beliefs about diseases can inhibit health education campaigns and trigger risk behaviour (e.g. Pitts *et al.* 1996). This paper will show that this scope needs to be further expanded to include linguistic theory and analysis by looking at a hypothetical drinking-water incident involving a 'do not drink' notice.

The UK Water Industry Act (1991; amended by the Water Act 2003) states that water companies must only supply water that is fit for human consumption (Section 70) and that if a breach of the drinking-water standards occurs, they must take appropriate action. Such action naturally includes investigating the breach, its cause, its likely effect on public health and restoring standards. They must also decide whether consumers need to be informed about the breach, including whether special advice needs to be issued. If public health is threatened, the three standard advices that could be issued are: 'boil water', 'do not drink' and 'do not use'. Conspicuously, the Drinking Water Inspectorate (DWI) has not issued any formal guidelines for water notices, while its US equivalent, the Environmental Protection Agency (EPA), has.

The DWI reported 92 incidents for 2005 (Colbourne 2006). The detailed list of incidents included in the report shows that in the majority of cases (80.4%) only general advice was communicated to affected consumers. In addition, 13 incidents prompted a 'boil water' notice, four triggered a 'do not drink' notice and in one case specific advice for vulnerable groups was reiterated. There were no 'do not use' notices in 2005. Of interest to us here are the four 'do not drink' notices (4.3% of all notices). Three of these were due to a burst main and one due to back siphonage.

The goal of water incident communication (and public health communication in general) is to ensure compliance with any suggested protective measures. However, there are surprisingly few studies that have investigated public compliance with water notices: only one could be found for the UK (O'Donnell *et al.* 2000) and only one includes a 'do not drink' notice (Winston *et al.* 2003). Angulo *et al.* (1997) and O'Donnell *et al.* (2000) found that a large proportion of affected consumers and households (31% and 20%, respectively) did, on at least one occasion, not boil the water before drinking it while the investigated 'boil water' notice was in place. Similarly, Winston *et al.* (2003) found a non-compliancy rate of 18%. In addition, the use of unboiled water for pets, brushing teeth and food preparation was quite widespread (O'Donnell *et al.* (2000); unfortunately, the other studies did not include risk behaviours other than drinking).

We could assume that the poor effectiveness of water notices can be partly due to the choice to typically inform the consumers using leaflets and various forms of mass media, given Griffin & Dunwoody's (2000) find that information about lead in drinking water distributed via direct mail or mass media was less effective than interpersonal contacts, especially with health professionals. But there is also the possibility that prior health beliefs (e.g. it is just good for the immune system to keep busy) and language (e.g. brushing teeth is not formally drinking) play a (more) significant role. Thus, part of the reason why typical incident information packages might not be able to completely prevent risk behaviour lies far away from the then and there of the actual incident. If people rely on prior knowledge to guide them, we should expect our participants to report higher compliancy rates since our hypothetical

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'do not drink' notice is more serious than previously studied 'boil water' notices; but if they lack sufficient prior knowledge we might not find a difference.

While we need to increase our efforts to investigate real incidents, we cannot afford to wait for events to unfold before evaluating and perfecting practices currently in place; especially for events warranting a 'do not drink' or 'do not use' notice, since these are (thankfully) very rare. This is where pre-incidence studies can be very valuable and is the first reason why we chose to adopt hypothetical scenarios for this study.

One could argue against the use of mock scenarios since it might only be in the event of real danger that people would definitely follow issued guidelines, and it is possible that the type of crisis can have an impact on risk behaviour and risk perception. For example, if a water notice is issued due to an act of terrorism, it is quite likely that individuals will be more outraged than if it was due to a natural disaster (cf. Keselman *et al.* 2005). Similarly, studies have shown that participants' risk perception was negatively affected when the information source in the hypothetical stories was switched from an uncontroversial, trusted and responsive agency to a controversial, distrusted and unresponsive one; more importantly, however, the participants' intended behaviour was not affected by the changes in the stories (Sandman *et al.* 1993). It is thus essential that we pursue a distinction between risk perception and risk behaviour, keeping in mind that our focus is on behaviour and compliance with water notices.

In fact, the second reason for using hypothetical scenarios is that they allow us to focus on typical language and general health beliefs without the complication of event-specific responses. Hypothetical scenarios are free from the often impractical nature of notices, which might be the main trigger for disobedience. Only drinking bottled water can be costly and fetching free bottled water is cumbersome. By offering the participants a scenario without a transmitter, with only one source (a hypothetical water company) and one receiver (the participant), much of the typical and natural amplification of risk has been removed (on risk amplification, see Pidgeon *et al.* (1999)). Left with only the message to decode, the participants' responses should therefore allow us to disclose what effect language combined with prior beliefs has on behaviour.

The message chosen for this study is very simple: 'do not to drink tapwater'. We predict that two of the words in this message are likely to trigger risk behaviour. First, the word *drink* might cause problems when deciding whether certain actions such as brushing teeth are safe, since these actions are not drinking actions. Second, the word *not* is an absolute, similar to *never, no one*, *nobody, nothing*, etc., and their absolute opposites *always, everyone, everything*, etc. Although they did not include the word *not* in their study, it is worth mentioning that Woloshin *et al.* (1994) found that only 67.8% of participants agreed that *never* meant 'not ever'. Absolutes are generally hedged in natural language, and we should thus expect to find a variation in interpretations ranging from 'absolutely not' to 'perhaps not', along with a variation in compliance with the water notice.

A seemingly clear and authoritative message such as 'do not drink' will result in a variety of behaviours ranging from safe to highly risky. It is possible that some behaviours are gender predominant, with males being more likely to display high risk behaviour (cf. Courtenay 2000), but we predict an overall similar behaviour for men and women. By identifying and evaluating the plausible behaviour in the event of a 'do not drink' notice, we hope to illustrate the potential effect on public health that risk behaviour based on linguistic misinterpretations can have.

METHODS

In order to assess the most likely behaviour in a variety of hypothetical events, a questionnaire was constructed. A web-based questionnaire was chosen in order to maximise participation. The questionnaire was compiled and posted online using PHPSurveyor. It consisted of a personal information section and a question section; all questions had to be answered. Participants were asked to state their gender, age, student status and ethnicity; they were also asked whether English was a native language (monolingual or bilingual).

A total of 12 behaviour questions were included. Of relevance to this paper, one of the questions dealt with what types of behaviours were considered safe to do after a 'do not drink' advice had been issued; respondents were asked to tick all behaviours they would exhibit (see Table 1).

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Table 1 | Water behaviour question

Question: Your water company tells you not to drink tapwater. What would you still do?
I would take a bath
I would take a shower
I would brush my teeth
I would wash the dog
I would water my plants
I would flush the toilet
I would change the water in the fish tank
I would make up baby bottles
I would boil the tapwater before I drink it
I would buy bottled water to drink

It should be noted that, in real crisis events, when a 'do not drink' notice is issued, affected residents are not forced to buy bottled water. Instead, bottled water is provided, usually by the water company, though the affected residents are normally instructed to fetch the bottles themselves from a local supply point. More importantly, free water is not always available at the very beginning of the water notice and thus residents often need to buy bottled water. Phrasing the last action as a 'buy action' rather than a 'fetch action' ensures that the participants had to consider and rate a potentially costly and cumbersome action, just as they might have to in the beginning of a real water incident. In addition, studies of 'boil water' notices have revealed that bottled water is generally favoured over having to boil the water (Harding & Anadu 2000).

Subsequent to ethical approval from King's College London's Research Ethics Sub-Committee (protocol number: REPSSPP(W)-05/-06-7), a recruitment e-mail outlining the study and inviting anonymous participation was sent out to 145 undergraduate students of English linguistics in London and 484 undergraduate students of English linguistics in Leicester; a total of 629 students were invited to participate. The choice to recruit only students was twofold: the participants would be of similar age and they would have similar literacy levels. London and Leicester were chosen because of their multiethnic populations. The survey was open for approximately two weeks (from 6–21 November 2006).

A total of 124 people responded (19.7% response rate), but two participants were excluded because they answered 'no' to the question whether they were students. In addition, students who did not have English as a native language were removed, leaving 107 students. 23.4% of these students were male and 76.6% female; this is most likely due to our choice of humanities students. The majority (94.4%) of the students were 25 years old or less; none of the participants were older than 35.

As Table 2 shows, the ethnic make-up of the current sample is similar to that established for the UK and UK Higher Education populations. The ethnic minorities of the UK are well represented in the sample, no doubt due to the demographics of the two chosen university communities in London and Leicester.

The frequency of participants answering that they would carry out a specific action as listed in the question was analysed. In addition, three further variables were calculated based on how the participant scored for the two behaviours 'boil and drink tapwater' and 'buy and drink bottled water', respectively. First, based on the combinations of replies to these two actions, four possible behaviours could be extracted: would only drink bottled water, would only drink boiled tapwater, would drink both bottled water and boiled tapwater, and would only drink unboiled tapwater.

Thereafter, these four calculated behaviours were ranked in accordance to how risky versus safe the behaviour is: drinking bottled water only was ranked as safest, drinking both bottled water and boiled tapwater was classified as low-medium risk, drinking only boiled tapwater was labelled medium-high risk, and drinking unboiled tapwater was determined as the riskiest behaviour. Note that the choice to label boiling less risky than no treatment

Table 2 | Ethnic make-up

Ethnic group	UK population [a]	UK Higher Education [b]	Current sample
White	92.1%	86%	72.9%
Black	2.0%	4%	4.7%
Asian	4.0%	8%	10.3%
Mixed	1.2%	n/a	10.3%
Other	0.8%	2%	1.9%

[a]UK population figures based on 2001 census (http://www.statistics.gov.uk).
[b]UK Higher Education figures based on 2002/2003 student cohort (http://www.hesa.ac.uk/).

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at all was based on the fact that none of the 'do not drink' notices in 2005 were due to lead or some other metal where boiling the water would be the unsafest action.

Finally, a third variable was calculated distinguishing between, on the one hand, the high risk group and, on the other, the other three behaviours (i.e. the safe, low-medium risk and medium-high risk groups). This variable was used for gender comparison of high risk behaviour.

The responses were analysed using different statistical approaches. Frequencies, Chi Square and Spearman's Rho were used to describe the preference and correlation between individual actions. The relationship between chosen behaviour and gender was analysed using Mann–Whitney and Fisher's Exact Test.

RESULTS

Upon submission, questionnaire responses were coded and entered into a database using the SPSS software. The participants' replies ('yes' or 'no') are displayed in Table 3. Reassuringly, none of the participants would use the tapwater in baby bottles; similarly, almost all of them would flush their toilets. However, for the majority of actions, participants seem unsure about what actions are safe.

Table 3 | Participants' responses

Question: your water company tells you not to drink tapwater. What would you still do?	Participants' replies	
	YES	NO
I would take a bath[a]	72 (67.3%)	35 (32.7%)
I would take a shower[a]	83 (77.6%)	24 (22.4%)
I would brush my teeth[b]	35 (32.7%)	72 (67.3%)
I would wash the dog	63 (58.9%)	44 (41.1%)
I would water my plants[a]	72 (67.3%)	35 (32.7%)
I would flush the toilet[a]	103 (96.3%)	4 (3.7%)
I would change the water in the fish tank[b]	29 (27.1%)	78 (72.9%)
I would make up baby bottles[b]	0 (0%)	107 (100%)
I would boil the tapwater before i drink it[c]	42 (39.3%)	65 (60.7%)
I would buy bottled water to drink[a]	94 (87.9%)	13 (12.1%)

[a]Significantly more students answered 'yes' ($\chi^2_{(1)}$, $p < 0.01$).
[b]Significantly more students answered 'no' ($\chi^2_{(1)}$, $p < 0.01$).
[c]Significantly more students answered 'no' ($\chi^2_{(1)}$, $p < 0.05$).

Several of the queried actions are not straightforward drinking actions and we can see that this has, in some cases, posed a dilemma for the participants when choosing a preferred behaviour. Brushing ones teeth, where water is not formally drunk, should definitely be avoided, yet 32.7% would still use contaminated tapwater for this. Similarly, more than half the sample (the difference is approaching significance: $\chi^2_{(1)} = 3.374$, $p = 0.066$) would still wash their dog, even though it is almost certain that the dog would lick its fur after the wash. The participants' pet fish would not fare quite as badly as their dogs, since 72.9% would not use the water when cleaning their fish tanks. Possibly, fish filtering water through their gills to breathe is close enough to drinking to warrant a more cautious approach.

Bathing and showering are both safe behaviours as long as no water is ingested, and although significantly more participants would carry on with these actions, as many as 16 of the students (15%) would not dare to bathe or shower.

The most important result concerns the participants' drinking-water behaviour. While the majority of the students (87.9%) would buy and drink bottled water, 13 of them would not – this is a problem, especially since as many as 39.3% of the participants state that they would boil the tapwater and then drink it. Had boiling the water rendered it safe to drink, a 'boil water' notice rather than a 'do not drink' notice would have been issued; here, the choice of notice is meant to signal that any drinking of water from the tap is unsafe.

As described in the methods section, the four possible drinking behaviours were calculated based on the participants' replies to two of the actions. Our analysis reveals that a staggering 44% of the students would actually drink the tapwater, whether first boiled or completely untreated. As Figure 2 shows, 56.1% would only drink bottled water, 31.8% would only drink boiled tapwater, 7.5% would drink both bottled water and boiled tapwater, and 4.7% would drink the water straight from the tap. It also shows that the greater the risk, the fewer the individuals selecting that risk behaviour.

It seems as if the participants were as unsure about the safety of bathing as they were ignorant of the dangers of drinking boiled tapwater when the tapwater has been

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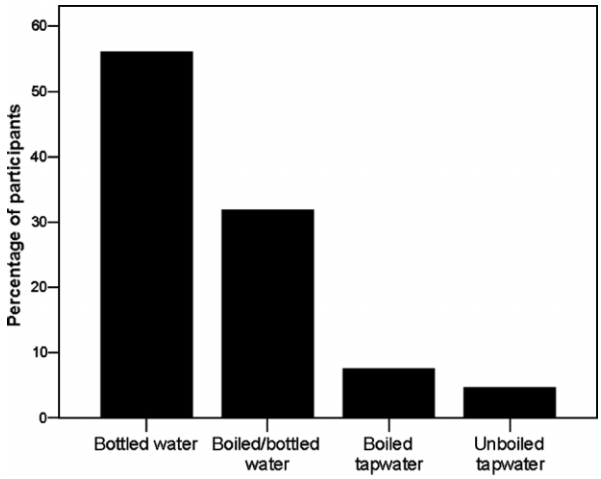

Figure 2 | The percentage of participants selecting between four behaviours.

labelled unsafe for drinking. In fact, 2 of the 16 students who would not bathe or shower indicated that they would only drink boiled tapwater, and six of them would drink both boiled tapwater or bottled water. We also find an interesting correlation between changing the water in the fish tank and drinking-water behaviour, so that those that would practice safe drinking-water behaviour would generally not change the water in the fish tank, whereas those who jeopardise their own health would be more likely to (unintentionally) kill their fish (Spearman's rho $= 0.223$, $p < 0.05$ (two-tailed)).

So far we have looked at rate of compliance for individual behaviours, notably drinking behaviour. It is also important that we get a measurement of the participants' overall risk behaviour. For this purpose, we counted the number of participants who would engage in at least one risky action involving themselves and/or their pets. We found that the majority of the students, namely 78%, would take some form of risk ($\chi^2_{(1)} = 32.533$, $p < 0.01$), leaving only 24 of the 107 students displaying full compliance.

Due to the size of the study, the only social factor that was analysed was gender. No significant difference was found in the responses to any of the ten tested actions, with one exception: significantly more female students would buy bottled water to drink ($U = 866.50$, $p < 0.05$).

To compare male and female behaviour preferences, we replotted the data in Figure 2, subdividing by gender. To counteract the gender imbalance of the sample (25 males versus 82 females), Figure 3 displays the behaviours in percentages within each gender group. After ranking the four behaviours from low to high risk, overall analysis shows no gender difference ($U = 896.50$, $p > 0.05$). The apparent discrepancy with our earlier result showing that females would drink more bottled water is an artefact of the regrouping of the responses. Whereas the former confirmed gender difference was the result of comparing all the participants who would buy and drink bottled water, we are now separating those that would only drink bottled water from those that would drink both bottled water and boiled tapwater.

From Figure 3 it is immediately obvious that the riskiest behaviour (i.e. drinking untreated tapwater) displays a strong male bias. Five of the 107 students would not buy bottled water, nor would they boil the tapwater before drinking it – hence they would drink the water straight from the tap. These five are all of the same age (19–21), but four are male and only one is female. Given the 25/82 ratio for males/females, we would expect more women than men to display this behaviour – just as we see (as expected) for the three other behaviours. Because of the small sample exhibiting this behaviour, we needed to carry out a Fisher's Exact Test for significance; for this reason it was necessary to amalgamate the three low- to medium-high risk groups. The test reveals a significant gender difference for drinking unboiled tapwater ($p < 0.05$).

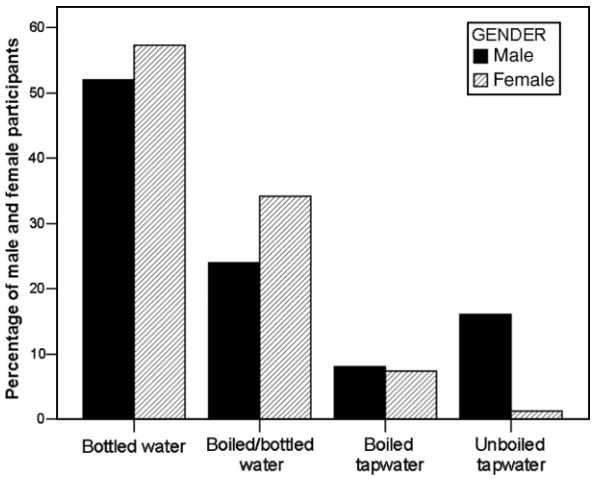

Figure 3 | The percentage of participants selecting between four behaviours subdivided by gender.

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DISCUSSION

The current study investigated the compliancy of 107 UK students with a hypothetical 'do not drink' water notice. The aim of the study was to show that the wording of the message can be less clear than expected and potentially have serious and far-reaching consequences.

We had expected to find a higher compliancy rate compared to previous studies of 'boil water' notices, since a 'do not drink' notice is more serious than a 'boil water' one. Surprisingly, we found that nearly half our sample would drink tapwater, compared to 20–31% in Angulo *et al.* (1997) and O'Donnell *et al.* (2000). In addition, the general non-compliance rate of 78% found here seems higher than the 64% reported for 'boil water' notices (O'Donnell *et al.* 2000). Without access to their raw data, it is not possible to tell if these differences are significant, but further studies are clearly warranted.

It is possible that these results indicate that the British public is generally not worried about poor drinking water quality. However, Green *et al.* (1999) found that the ranking for 'drinking water quality' ranged from 3–4 (where 1 is highest concern and 19 is least concern) when viewing from a public perspective. Additionally, the design of the study has already eliminated the source and transmitter, along with other risk amplification factors; and the use of university students means that we cannot explain the misunderstanding of *do not drink* in terms of literacy (on public health literacy see, for example, Gazmararian *et al.* (2005)) or age differences.

With regard to gender, we hypothesised an overall similarity in behaviour, and indeed the differences in preference for listed actions and drinking behaviour was generally nowhere near significant. There were, however, two gender biased behaviours: female students showed a greater preference for bottled water and predominantly male students engaged in high risk behaviour. Both these results support our prediction that, in the event of any differences, we should find women opting for the safer behaviour and men for the more risky one; thus confirming previous studies of gender, health and risk taking (e.g. Byrnes *et al.* 1999; Courtenay 2000; Turner & McClure 2003). To explain the majority of our results, we must, however, turn to the language of the message and the prior knowledge of the participants.

The mental representations model put forward earlier (see Figure 1) argues that language has two roles to play in the formation of mental representations and in the understanding and comprehension of messages. When a hearer or reader first comes across a message, they will access the words in that message and retrieve them and their meanings from the mental lexicon (cf. Aitchison 1994). Upon successful retrieval, these words will allow the formation of a mental representation of the message; but the words will also trigger the recipient to construct a context that is essential when building a mental representation. The context is formed from the knowledge, beliefs and experiences that are recalled together with the meanings of the words; for example, when retrieving the word *drink*, we also retrieve occasions involving drinking – often to the extent that we can almost feel liquid pouring down our throat.

In general, water notices contain lists of unsafe (and sometimes safe) actions so that the consumers do not have to resort to the title of the notice alone when trying to decide on best practise, assuming that consumers will read (or hear) the notice in full. Unfortunately, it is beyond the scope of this paper to discuss consumer reading habits, but safe to say, some consumers will be quite unlikely to read all of it. Thus, it must be assumed that the name of the notice usually carries most of the meaning across to the public. For the current study and the message 'do not to drink', we predicted that the mental representations for the words *drink* and *not* could potentially cause misunderstandings and trigger incorrect behaviour.

Although the water notice in question is not 'do not use', there is a certain overlap with that type of notice. Despite its name, the 'do not drink' notice is not restricted to drinking actions. The mental representation necessary for correct behaviour needs to be of any and all actions that might result in the contaminated water entering the person's mouth; from eating vegetables rinsed in the water, to brushing teeth and dogs licking their fur after having been washed.

As we have seen, non-drinking actions did result in a variety of behaviours. Sometimes, the incorrect behaviour was risky, as in the case of brushing teeth, washing the dog and changing the water in the fish tank; but in some cases the participant chose an over-precautious behaviour, for example not showering or bathing. It should be noted that

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these variations between safe and risky behaviour were not exclusively between-subjects variations; in fact, half the students who were overly cautious about bathing and showering would still drink the tap water (albeit only after boiling it).

We suggest that these variations in behaviour signify variations in mental representations, where only some of the students were able to produce a mental representation similar to that of the issuing water company. While many of the students understood that *drink* did not simply refer to drinking actions, several of them did not infer the word's extended meaning. We need to distinguish between a word's formal (or lexico-semantic) meaning and its use in real life (i.e. its pragmatic meaning). Even for seemingly simple messages, comprehension often relies on inferring the intended pragmatic meaning rather than relying on the retrieved semantic meaning.

We also hypothesised that the word *not* would lead to misinterpretations and consequently to risk behaviour. Everyday conversations are littered with overstatements and understatements – for example, *I'm dying of hunger* (when very hungry) or *Oh this little scratch* (of a serious cut) – and most of us have a tendency to insert absolutes such as *never* and *always* when trying to persuade others – who, in turn, most likely have learnt to disregard them. Over time, absolutes take on pragmatic, less absolute, meanings.

Woloshin *et al.* (1994) tested ten probability terms, asking members of the public to give estimates of how many of 100 people would be affected judging from the term used. Of particular interest here are *certain* and *never*: 80.3% agreed that *certain* meant all 100 people were affected and only 67.8% agreed that *never* meant none of the 100 people were affected. But even in the professional community, absolutes are ambiguous. Bryant & Norman (1980) found that physicians associated *certain* with a probability of 0.95 and *always* with 0.94.

Figure 4 illustrates the conceptualisations of probability associated with typical probability terms. The semantic scale (top) locates *possible* at the very middle of the scale whereas its location on the everyday pragmatic scale (bottom) is towards the negative end. With regard to the absolutes at both ends of the semantic scale, they take up distinctly different locations compared to the explicitly hedged *almost never* and *almost certain*. However, on the

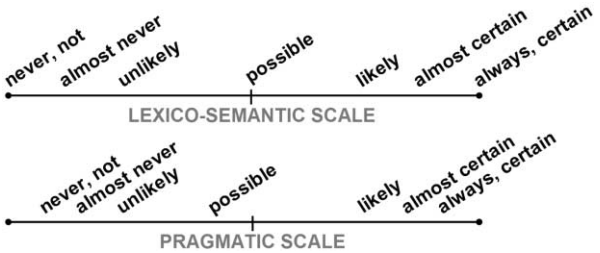

Figure 4 | Lexico-semantic (/formal) *versus* pragmatic (/everyday) scales of probability, including absolutes (based on Woloshin *et al.* (1994) and Bryant & Norman's (1980) results; we have added *not*, synonymous with *never*).

pragmatic scale, the implicit hedging of absolutes in everyday language has resulted in them moving much closer towards the explicitly hedged terms, which in turn are pushed slightly closer to the centre of the scale.

The intended meaning for *not* is its semantic meaning (i.e. 'not at all' with corresponding numerical probability of 0.00 or 0%), since the consumers are not to drink (or ingest) water in any way, form or shape. But it is not surprising that people instead draw the meaning from the pragmatic scale and thus interpret the 'do not drink' notice as not necessarily applying all the time.

As our cognitive model stipulates, retrieval of prior knowledge is also essential for mental representation formation. Our participants have no doubt retrieved a variety of prior knowledge about water, drinking, the body and illnesses as well as beliefs about possible contaminants and reasons for the hypothetical notice. This is particularly evident in the 39.3% of participants who stated that they would boil the water before drinking it. Spurred on by the assumption that the 'do not drink' notice could possibly hint at occasional safe drinking of tapwater, their belief that contaminated water can be rendered safe by boiling leads them to conclude that the notice actually means 'preferably do not drink tapwater unless it has first been boiled'. Surprisingly, most 'do not drink' notices used in the UK and the US do not state that boiled water is unsafe. As a result, the frequently hedged meaning of *not* together with the recalled prior knowledge prevents our hypothetical consumers from taking safe action.

It is especially important to understand that a 'do not drink' notice is more serious than a 'boil water' one. Though some general disobedience is to be expected, it is, therefore, very worrying to find a higher non-compliancy rate for both overall risk behaviour and for risky drinking behaviour.

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This increase is most likely due to the public not knowing the difference between the standard types of notices, and they consequently confuse the 'boil water' and 'do not drink' notices. This confusion is promoted by the linguistic ambiguity of the notice itself; ironically, while we want the consumers to go beyond the literal meaning for *drink*, we do not want them to do the same for *not*.

CONCLUSIONS

Water incidents prompting a 'do not drink' water notice can pose a serious threat to public health if suggested precautionary actions are not relayed and observed by the public. Because such incidents and consequently efficacy studies are rare, pre-incidence studies should be carried out. The use of hypothetical scenarios also allows the message (the water notice) as the focus rather than the source or transmitter. The cognitive model put forward here argues that the mental representations that guide risk perception and, in turn, behaviour are shaped directly and indirectly by the language of the message. The indirect influence stems from language triggering recall of prior knowledge and health beliefs.

Analysis of responses from 107 undergraduate students in the UK showed that 44% would drink the tapwater despite the issued water notice and a total of 78%, would engage in at least one risky action involving themselves and/or their pets. We also found that men were more likely to display high risk behaviour and women were more likely to buy bottled water. The non-compliancy rates uncovered here are higher than those found by Winston *et al.* (2003) and for 'boil water' notices (Angulo *et al.* 1997; O'Donnell *et al.* 2000) and it is essential that further studies are carried out.

We have traced these worrying results to misunderstandings of the words *drink* and *not*. In order to correctly interpret the water notice, it is assumed, on the one hand, that consumers will infer the intended pragmatic meaning rather than rely on its lexico-semantic meaning for *drink* (i.e. 'drinking and other actions that could result in ingesting liquids' versus 'drinking') and, on the other hand, that they will not go beyond the literal meaning for *not* (i.e. a probability of 0.00 versus a pragmatically hedged 0.05). The misinterpretation of *not* also seems to have fuelled the belief that boiling water purifies it.

We have shown that the current 'do not drink' water notice practise is confusing to the public. Based on this study, three main courses of action are recommended. In order to ensure public health and safety long term, the phrase 'do not drink' along with alternative water notice titles should be evaluated, e.g. through a focus group study incorporating as full a range of stakeholders as possible, in the hope that a more comprehensible, memorable and effective title can be found. In the short term, water companies and the DWI need to make sure that the intended semantic or pragmatic meanings of 'do not drink' are successfully conveyed to the consumers by including a brief summary on the different types of water notices, especially contrasting 'do not drink' and 'boil water', in all water notices issued (inclusion of explanatory additional sentences have proven successful in health communication (Marteau *et al.* 2001)). Finally, the usefulness of generic national water notice templates should also be considered.

ACKNOWLEDGEMENTS

The author wishes to thank the participants at the Institute for Public Health and Water Research (IPWR) conference *Water Contamination Events: Communication with Consumers*, especially Virginia Murray. Please note that the views expressed in this paper are those of the author and do not reflect the official position of IPWR. The author would also like to thank Paul Hunter for constructive comments in the preparation of this paper. Special thanks are due to Orietta DaRold for assisting with recruitment.

REFERENCES

Aitchison, J. 1994 *Words in the Mind: An Introduction to the Mental Lexicon*. Blackwells, London.

Angulo, F. J., Tippen, S., Sharp, D., Payne, B. J., Collier, C., Hill, J. E., Barrett, T. J., Clark, R. M., Geldreich, E. E., Donnell, D. H. & Swerdlow, D. L. A. 1997 Community waterborne outbreak of Salmonellosis and the effectiveness of a boil water order. *Am. J. Public Health* **87**(4), 580–584.

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Bryant, G. D. & Norman, G. R. 1980 Expressions of probability: words and numbers. *N. Engl. J. Med.* **302**, 411.

Byrnes, J. P., Miller, D. C. & Schafer, W. D. 1999 Gender differences in risk taking: a meta-analysis. *Psychol. Bull.* **125**(3), 367–383.

Colbourne, J. 2006 *Drinking Water 2005*. Drinking Water Inspectorate, London, http://www.dwi.gov.uk.

Courtenay, W. H. 2000 Constructions of masculinity and their influence on men's well-being: a theory of gender and health. *Soc. Sci. Med.* **50**, 1385–1401.

Doria, M. F., Abubakar, I., Syed, Q., Hughes, S. & Hunter, P. R. 2006 Perceived causes of sporadic cryptosporidiosis and their relation to sources of information. *J. Epidemiol. Community Health* **60**, 745–750.

Gazmararian, J. A., Curran, J. W., Parker, R. M., Bernhardt, J. M. & DeBuono, B. A. 2005 Public health literacy in America An ethical imperative. *Am. J. Prevent. Med.* **28**, 317–322.

Green, E., Short, S. D., Duarte-Davidson, R. & Levy, L. S. 1999 Public and professional perceptions of environmental and health risks. In *Risk Communication and Public Health* (ed. P. Bennett & K. Calman), pp. 51–64. Oxford University Press, Oxford.

Griffin, R. J. & Dunwoody, S. 2000 The relation of communication to risk judgment and preventive behavior related to lead in tap water. *Health Commun.* **12**, 81–107.

Griffin, R. J., Dunwoody, S. & Zabala, F. 1998 Public reliance on risk communication channels in the wake of a Cryptosporidium outbreak. *Risk Anal.* **18**(4), 367–375.

Harding, A. K. & Anadu, E. C. 2000 Consumer response to public notification. *J. AWWA* **92**(8), 32–41.

Health and Safety Executive 2006 *Carrying Dangerous Goods: Common Problems*. Health and Safety Executive, UK. Available at: http://www.hse.gov.uk/cdg/manual/commonprobs.htm.

Hunter, P. R. & Syed, Q. 2001 Community surveys of self-reported diarrhoea can dramatically overestimate the size of outbreaks of waterborne cryptosporidiosis. *Wat. Sci. Technol.* **43**, 27–30.

Keselman, A., Slaughter, L. & Patel, V. L. 2005 Methodological review: toward a framework for understanding lay public's comprehension of disaster and bioterrorism information. *J. Biomed. Inform.* **38**, 331–344.

Kintsch, W. 1998 *Comprehension: A Paradigm for Cognition*. Cambridge University Press, Cambridge.

Marteau, T. M., Senior, V. & Sasieni, P. 2001 Women's understanding of a "normal smear test result": experimental questionnaire based study. *Brit. Med. J.* **322**, 526–528.

O'Donnell, M., Platt, C. & Aston, R. 2000 Effect of a boil water notice on behaviour in the management of a water contamination incident. *Commun. Dis. Public Health* **3**, 56–59.

Pidgeon, N. F., Henwood, K. L. & Maguire, B. T. 1999 Public health communication and the social amplification of risks: present knowledge and future prospects. In *Risk Communication and Public Health* (ed. P. Bennett & K. Calman), pp. 65–80. Oxford University Press, Oxford.

Pitts, M., McMaster, J., Hartmann, T. & Mausezahl, D. D. 1996 Lay beliefs about diarrhoeal diseases: their role in health education in a developing country. *Soc. Sci. Med.* **43**(8), 1223–1228.

Renn, O. 1991 Risk communication and the social amplification of risk. In *Communicating Risks to the Public* (ed. R. E. Kasperson & P. J. M. Stallen), pp. 287–326. Kluwer, Dordrecht.

Sandman, P. M., Miller, P. M., Johnson, B. B. & Weinstein, N. D. 1993 Agency communication, community outrage, and perception of risk: three simulation experiments. *Risk Anal.* **13**(6), 585–598.

Slovic, P. 1987 Perception of risk. *Science* **236**(4799), 280–285.

Stewart-Taylor, A. J. & Cherrie, J. W. 1998 Does risk perception affect behaviour and exposure? A pilot study amongst asbestos workers. *Brit. Occup. Hygiene Soc.* **42**, 565–569.

Turner, C. & McClure, R. 2003 Age and gender differences in risk-taking behaviour as an explanation for high incidence of motor vehicle crashes as a driver in young males. *Injury Control Safety Promot.* **10**(3), 123–130.

Whorf, B. 1941 The relation of habitual thought and behaviour to language. In *Language, Culture, and Personality, Essays in Memory of Edward Sapir* (ed. L. Spier), pp. 75–79. Sapir Memorial Publication Fund, Menasha.

Winston, G., Lerman, S., Goldberger, S., Collins, M. & Leventhal, A. 2003 A tap water turbidity crisis in Tel Aviv Israel, due to technical failure: toxicological and risk management issues. *Int. J. Hygiene Environ. Health* **206**, 193–200.

Woloshin, K. K., Ruffin, M. T. & Gorenflo, D. W. 1994 Patients' interpretations of qualitative probability statements. *Arch. Fam. Med.* **3**, 961–966.

First received 2 April 2007; accepted in revised form 14 July 2007.

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