Demographic determinants of chemical safety information recall in workers and consumers in South Africa.

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DECLARATION

I, Farzana Sathar, Student No. STHFAR001, declare that the work that I have submitted is my own and where the work of others has been used (whether quoted verbatim, paraphrased or referred to) it has been attributed and acknowledged.

Signature: Signed by candidate Signature Removed

Date: 14/08/2015

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INTRODUCTION

Chemical hazard communication is intended to alert users of the potential hazards of chemicals which promote safe behaviours in order to prevent harmful exposure. Hazard communication may be in the form of labels and safety data sheets (SDS) (London & Rother, 2003; Ta et al., 2010). Apart from the fact that hazard information should be understood or comprehended, it is also important that it should be recalled. Recall can be defined as the process of retrieving words or pictures from memory (Houts et al., 2006). Recall of hazard communication is critical when the written form of the information is not available at the time it is required.

1.1 Problem statement

Extensive information is stored in a person's memory which may cause difficulty when trying to recall specific information. One aspect which contributes to the effectiveness of warnings is their ability to remind the user of previously stored knowledge during a critical moment (Lesch, 2008b). This recall of information is important for workers and consumers in developing countries in order to prompt safe behaviours during chemical use. Factors influencing the ability to recall chemical safety information still remain to be explored. Therefore, this study aims to evaluate whether demographic factors contribute to the recall of chemical safety information in developing country workers and consumers in order to impact future training methods which enhance recall.

1.2 Justification

In order to harmonise chemical hazard communication, the Globally Harmonised System of Classification and Labelling of Chemicals (GHS) was endorsed in 2002 by the United Nations Committee on Experts on the Transport of dangerous goods (UNCETDG) (Rother &

London, 2008). The GHS aims to promote human and environmental safety, facilitate international trade of chemicals and provide adequate information on chemicals (Rother & London, 2008; Dalvie et al. 2014). This harmonisation of information that is contained on labels and SDS is perceived to provide consistent information which in turn is intended to promote better comprehension and recall of chemical hazard information, and safe behavior. Figure 1 below illustrates the nine GHS pictograms which are used on GHS-compliant labels. Although the GHS will harmonise information and also provide an outline for countries that do not have a chemical hazard communication system in place, implementation is however, voluntary. This study intends to contribute to improvement of GHS training and policy implementation in South Africa specifically and Low and Middle Income Countries (LMIC) in general to improve the recall of chemical safety information.

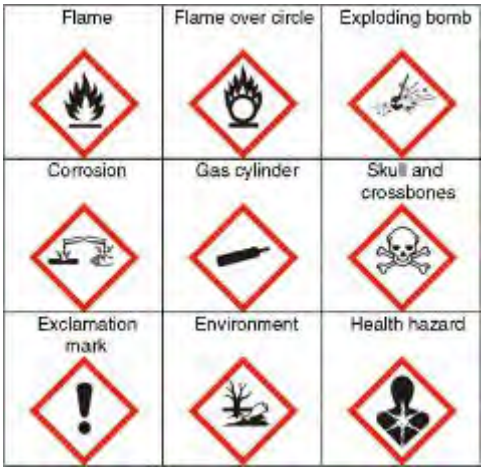

Figure 1: The nine GHS pictograms used on GHS-compliant labels (Diamond shapes around pictogram are always red) (Boelhouwer et al., 2013)

1.3 Research question

What are the factors that determine the recall of chemical safety information found on GHS compliant hazard warning and information tools amongst four sectors of users in the Western Cape and Gauteng provinces of South Africa?

1.4 Aim

This study will investigate factors that may impact recall of chemical safety information on labels and safety data sheets amongst workers and consumers in two provinces of South Africa. We hypothesise that the predictor variables such as age, gender or previous training are associated with the recall of this chemical safety information.

1.5 Objectives

The study objectives are:

- To describe the demographic profile of the study population.
- To determine prompted and unprompted recall of the workers and consumers of hazard information on labels and SDS's.
- To determine which factors predict prompted and unprompted recall of hazard information on labels and SDS's.

2. LITERATURE REVIEW

Not many studies could be found that specifically investigated recall of hazard communication information so the sections below describes the findings of studies that investigated comprehension which could have relevance to recall since they are both cognitive processes.

2.1 Levels of comprehension among different users of chemical safety information

Chemicals have different properties with varying degrees of hazards as they may be flammable, corrosive, explosive, toxic or harmful to the environment. Therefore, it is important for users to understand the potential hazards that are displayed on the warning labels or SDS in order to promote safe chemical use. Previous studies have shown that the comprehension of hazard communication is low among those who are exposed to hazardous chemicals (Adane & Abeje, 2012; Banda & Sichilongo, 2006; Boelhouwer et al., 2013;

Dalvie et al., 2014). For instance, in a study of university students in Ethiopia, majoring in chemistry or biology, it was found that they were unfamiliar with chemical hazard information (Adane & Abeje, 2012). Similarly, a paper presenting descriptive results of a South African study showed that consumers and workers have low comprehensibility of hazard communication (Dalvie et al., 2014). A study with Malaysian industrial workers revealed that the GHS flammable symbol was the most understood and the compressed gas the least understood (Figure 1; Ta et al., 2010). Similarly, in the paper by Dalvie et al., (2014) the skull and crossbones and flammable symbols (Figure 1) were well understood whereas the corrosive and compressed gas symbols were poorly understood. Dalvie et al., (2014) concluded their study by suggesting that low comprehensibility is likely due to low levels of training and that training should incorporate comprehension of pictograms as they are most easily recalled, however, poor comprehension could also be related to the quality of the symbols. Likewise, Adane & Abeje (2012) also elaborated that training should target recall and recognition of information.

2.2 Impact of training and age on comprehension

As indicated above, Dalvie et al., (2014) and Adane & Abeje (2012) found that low comprehensibility is likely due to low levels of training and that training should improve comprehensibility and recall of hazard information material.

A study conducted by Lesch (2003), in the United States of America (USA), investigated the impact of training on the comprehension of symbols among participants recruited through advertisements in local newspapers using symbols such as ‘biohazard’ or ‘cancer-causing substance’ which were supplied by a safety label manufacturer. The training involved three types of associated texts/labels for the experimental symbols, a) only the name of the symbol, b) a sentence describing the symbol, and c) an accident scenario involving the symbol. After all these labels were demonstrated to the participants, they were then shown a correct and an

incorrect label from which they had to decide which statement matched the symbol. This study showed that training dramatically improved comprehension which was found to be greater among the younger participants aged between 18 and 35 years (88% correct) compared to the older participants aged between 50 and 67 years (68% correct) (Lesch, 2003). In a study conducted a few years later in which Lesch (2008a) again recruited participants from the USA through advertisements in local newspapers, they investigated the impact of two different training methods on comprehension, a) only the name of the symbol and b) an accident scenario involving the symbol. Training and testing was done in the same way as in the study by Lesch (2003). It was found that there was no difference in comprehension between the younger participants aged between 20 and 35 years (43% correct) and older participants aged between 50 and 70 years (41% correct) (Lesch, 2008a). These studies indicate that training improves comprehension, while the influence of age on symbol comprehension is unclear. It is likely that the effect of training and age on comprehension of hazard information also applies to recall of hazard information.

2.3 The effect of demographic factors on the comprehension of safety information

There are a number of demographic variables to consider such as age, gender, training and colour blindness which all influence warning effectiveness because these differences impact on the comprehension of warning information (Wogalter et al., 2002; Laughery, 2006; Laughery & Wogalter, 2014). There are also other personal factors that could influence comprehension such as culture, ethnicity, individual differences and familiarity (Wogalter et al., 2002). A survey of four target sectors (agricultural, industrial, transport and consumer) in Zambia found that the level of education, gender and age did not influence the comprehension of label elements such as the colours, signal words and symbols (Banda & Sichilongo, 2006). This was measured by respondents ranking combinations of the different signal words (e.g. caution or warning), symbols and different colour codes in the order of the

most danger implied. It was also found that comprehension was low among these sectors and there was a difference in the failure to explain the meaning of the symbols between sectors, evaluated by the author as correct/incorrect, agriculture (67%), transport (63%), industry (31%) and consumers (85%). However, it is possible that this method of ranking may not be related to comprehension. In a study on 150 Malaysian industrial workers, it was revealed that a tertiary level education improved the comprehension of GHS symbols compared to those with who completed secondary or primary school (Ta et al., 2010). This study also found that a higher position in the workplace leads to a better comprehension of GHS symbols, whereas gender and age did not contribute to the comprehension of symbols.

2.4 Recall of hazard communication

As previously mentioned, there are not many studies been done which primarily focuses on the recall of hazard communication. However, some of the studies that examine comprehension make inferences about recall. It has been suggested that pictures are noticed and recalled more easily than words (Davies et al., 1998; Wogalter et al., 2002; Houts et al., 2006; Boelhouwer et al., 2013). This has been found in previous studies conducted in South Africa and Malaysia which showed that the pictogram was the most frequently recalled element on the label after giving it to the subject for one minute and then withdrawing it (Dalvie et al., 2014; Ta et al., 2010). These two studies used the GHS pictograms and the skull and crossbones and the flammable symbol were found to be the most recognised in both studies.

3. METHODOLOGY

3.1 Study design

This study involves analysis of a sub-set of data that was collected as part of a larger study in 2003. The researcher's involvement is mainly the development of outcome variables, and the

subsequent analyses and write-up. Some parts of the methods section in the protocol are therefore written in the past tense.

The main study was a cross-sectional analytic study that investigated the comprehensibility of chemical hazard communication tools developed by the University of Cape Town amongst 400 workers and consumers in the Western Cape and Gauteng provinces of South Africa (London et al, 2003; Dalvie et al, 2014). The four sectors of chemical users investigated were industry, transport, agriculture and consumers. The choice of such design was influenced by the descriptive nature of the study. This study will examine the extent to which a pre-selected set of predictor variables contribute to recall of chemical hazard communication among a group of consumers and workers.

3.2 Study population

The study was intended to provide a snapshot view of the comprehensibility of chemical hazard information to support the implementation of the GHS in South Africa. The study population is therefore taken to reflect employees with potential exposure to chemicals (e.g. farmers, factory workers) as well as consumers who are likely to be affected (e.g. hairdressers).

3.3 Sampling

It was proposed to include 100 subjects from each sector, with 50 each from the Western Province and Gauteng (London et al., 2003). Within the four sectors, there were different types of sampling procedures and participants were stratified accordingly. Chamber of Commerce lists from 2003 were used as the sampling frame for the industrial and transport sectors. In general, every workplace sampled aimed to include a range of production workers, shop stewards/safety representatives, managers/supervisors and technical (e.g. laboratory) staff. If a company declined to participate, or did not respond, one substitution was allowed

from the company next on the list. However, even after an allowed substitution, the substituted company may not have participated. This non-participation differed across sectors and sub-sectors, resulting in different sample sizes for each province.

Industry

The industrial sector included workers, managers, factory supervisors and laboratory scientists. The sample included a chemical stratum (users and generators of chemicals such as laboratory workers) and non-chemical stratum which consisted of a combination of Standard Industrial Classification categories (mining, paper, textiles, electricity, gas and water, construction, wholesale and retail trade, health care, domestic works, and cleaning industries) and was about twice the size of the other sectors. The strata were further categorized by company size which was determined by the number of employees; Small = < 20 employees; Medium = 20 to 199 employees; Large = >200 employees.

Transport

The transport sector included road, rail, air and sea transport. It was stratified by companies exclusively involved in transport and companies who maintained transport fleets (e.g. petroleum). The strata were further categorized by company size which was determined by the number of employees; Small = < 20 employees; Medium = 20 to 199 employees; Large = >200 employees.

Agriculture

The agricultural sector included farm workers, managers and other related agricultural workers. Due to limitation in access, farms were selected by opportunistic sampling and were stratified by large commercial farming, small commercial farming and emergent farmers.

Consumer

Consumers were sampled by opportunistic sampling from supermarkets, laundromats, hairdressers and hardware shops. They were stratified by urban and rural consumers.

The final sample realised for all sectors is shown in Table 1 below.

Table 1: Sample from each province

	Cape Town	**Gauteng**	**Total**
Industry (chemical)	62	24	86
Industry (non-chemical)	63	27	90
Transport	44	28	72
Agriculture	55	12	67
Consumer	67	20	87
TOTAL	**291**	**111**	**402**

3.4 Recruitment procedures

Staff were recruited to undertake design and field piloting of the tool (Appendix A) (two staff) as well as for main field testing (nine staff). Collaboration with the National Centre for Occupational Health was secured to provide a base for Gauteng-based field-testing. Students from both the Peninsula and Vaal Technikons were recruited to assist. Piloting was used in a two-day training workshop on questionnaire administration and problem-solving skills.

3.5 Sample size calculation

Results from the main study (London et al, 2003; Dalvie et al., 2014) were used in sample size calculations. A two-sample test for equality of proportions was used (Stata corporation 2011) comparing unprompted recall of the skull and crossbones symbol (element with highest recall) in the industry and agricultural sectors (ratio=1, power=80%). The calculated sample size was 60 indicating that this study has sufficient power.

3.6 Measurements

The Hazard Communication Comprehensibility Testing (CT) Tool developed for testing comprehensibility of the GHS was used in the main study (London et al, 2003). The tool consisted of seven test modules that were comprised of questionnaires and procedures specifically designed to test the comprehension of hazard communication material. For this sub-study only data generated from module 2 which relates to the demographics, and module 3 which relates to the recall of the participants (Appendix A) will be described.

Labels were specifically designed for the study and were based on real chemicals (e.g. acetone, cholorpyrifos). The labels carried hypothetical brand details (such as trade names, manufacturer, address, contact details, etc.) to avoid situations where workers familiar with a particular chemical perform better than others because of familiarity.

3.6.1 Pilot study

The tool was evaluated in a pilot study conducted in Zambia in June 2002, with the support of the United Nations Institute for Training and Research (UNITAR) and with consultant support from the CEOHR at UCT. Based on this piloting, the modules were shortened, questions were changed and reorganised. Also, a manual to accompany the questionnaires was compiled as a guide for the interviewers. Following tool refinement, there was further piloting on a convenience sample of 10 to 15 subjects (drawn from the targeted sectors) in the Western Cape region.

3.6.2 Recall relevant modules

Of the seven modules, module 2 and 3 were relevant for testing recall. For module 2, participants were administered a face-to-face demographic questionnaire (items included information on gender, education, employment details and work experience) and a test for visual acuity (using Snellem's E) and colour blindness (using Ishihara plates). For module 3,

one of two labels were randomly selected by the interviewer, either *Saloc* or *Bayetone* (Appendix B). The participants were provided with the label and they were allowed to look at it for 60 seconds after which it was taken away from them. They were then questioned on their familiarity with the label, for example, whether or not they have seen it before. Thereafter, they were asked what they could remember on the label. This is referred to as unprompted recall. The label elements that were recalled were marked off and the remainder of the label elements were mentioned and they were asked if they remembered it, this is referred to as prompted recall.

3.6.3 Questionnaire administration

The questionnaires in modules 2 and 3 were administered in the form of face-to-face interviews by trained interviewers in the spoken language of the interviewee (e.g. English, Afrikaans). Companies provided appropriate venues to interview workers, while consumers were interviewed in malls, or in venues provided by supermarkets and shops. Domestic workers were interviewed in private homes, as were employers of domestic workers.

3.6.4 Outcome measures

The primary outcome measure for this sub-study is recall which has been operationalised as a dichotomous variable (Yes/No). Both prompted and unprompted recall will be analysed with respect to its relationship with the predictor variables including age, gender and education.

3.7 Data analysis

Analysis will be performed using STATA version 12.1 (Stata corporation 2011). Shapiro-wilk test and histograms will be used to test for normality of continuous variables. Scatter plots will be used to determine distributions of continuous variables. Pearson or Spearman rank correlation will be used to measure the degree of correlation and explore the possibility of multi-collinearity of continuous variables. Since the outcome variable (recall) is a

dichotomous variable bivariate analysis will include logistic regression to assess the association between the predictor variables and the outcome variables. Predictors with an association with recall (p-value was ≤ 0.1) will be included in multivariate analysis. Multiple logistic regression analysis will be performed to determine the association between recall and the predictor variables. A forward selection model building strategy will be used to assess the relationship between the predictors and the outcome variable. A list of the variables is presented in Table 2 below.

Table 2: List of variables

Variable	Type	Units/categories
Predictor variables		
Province	Categorical	Western cape Gauteng
Sector	Categorical	Industry Transport Agriculture Consumer
Gender	Dichotomous	Male or Female
Age	Continuous	Years
Married	Dichotomous	Yes or No
Children	Dichotomous	Yes or No
Language of interview	Categorical	English Afrikaans IsiXhosa Tswana Sotho IsiZulu Others
Home language	Categorical	English Afrikaans IsiXhosa Tswana Sotho IsiZulu Others
Read English	Dichotomous	Yes or No
Read Afrikaans	Dichotomous	Yes or No

School attendance	Categorical	Non Primary school High school
Further education	Dichotomous	Yes or No
Usually wearing glasses	Dichotomous	Yes or No
Wore glasses when tested	Dichotomous	Yes or No
Have impaired visual acuity	Dichotomous	Yes or No
Colour blind	Dichotomous	Yes or No
Occupation	Categorical	driver, production worker, skilled, general worker, unemployed, domestic, stevedore, pensioner, driver assistant, cargo loader, family member, housewife, fire officer, sprayman, manager, student, health professional, lab worker production worker, general worker, store operator, seafaring laborer, unskilled
Training	Dichotomous	Yes or No
Response variables		
Do you remember the following?		
Correct chemical name	Dichotomous	Yes or No
Symbols		
Skull and crossbones symbol	Dichotomous	Yes or No
Flammable symbol	Dichotomous	Yes or No
Environmental hazard symbol	Dichotomous	Yes or No
Signal word		
Danger or Warning	Dichotomous	Yes or No
Statement		
Hazard information	Dichotomous	Yes or No
Active ingredient acetone	Dichotomous	Yes or No
Quart	Dichotomous	Yes or No
Harmful or fatal if swallowed	Dichotomous	Yes or No
Work in adequate ventilation	Dichotomous	Yes or No
Avoid prolonged or repeated breathing of vapour	Dichotomous	Yes or No
Causes skin and eye irritation	Dichotomous	Yes or No
May cause reproductive effects	Dichotomous	Yes or No
Emergency contact phone number	Dichotomous	Yes or No
Use of protective clothing	Dichotomous	Yes or No
Protect from freezing	Dichotomous	Yes or No
First aid & treatment		
Flush eyes or skin with water	Dichotomous	Yes or No

Remove contaminated clothes and shoes	Dichotomous	Yes or No
Remove to fresh air	Dichotomous	Yes or No
Artificial respiration	Dichotomous	Yes or No
If swallowed, do not induce vomiting	Dichotomous	Yes or No
Give large amount of water	Dichotomous	Yes or No
Causes skin and eye irritation	Dichotomous	Yes or No
Difficult breathing, give oxygen	Dichotomous	Yes or No
Empty, uncleaned drums are dangerous	Dichotomous	Yes or No
Keep label until decontaminated	Dichotomous	Yes or No
In case of emergency	Dichotomous	Yes or No
Call appropriate services	Dichotomous	Yes or No

3.8 Study limitations

The study was restricted to the Western Cape and Gauteng provinces and was limited to four sectors which restricts the representivity of the sample. However, there is no reason to anticipate that the results for the other provinces would be much different.

3.9 Ethics and communications

This study was done in accordance with the Declaration of Helsinki of the 64th World Medical Assembly (WMA, 2013). The main study was approved by University of Cape Town's Research Ethics Committee (ethics number 107/2004). The protocol for the sub-study will also be submitted for university ethics approval. All participants were given information on what the study was about and asked for their consent before inclusion consistent with ethical standards of the University of Cape Town. Consumers who participated were reimbursed for their time (R50). A copy of the consent form is attached (Appendix C).

Confidentiality will be maintained further during subsequent analysis as only the researcher will have access to the data. Only aggregate data will be presented in the reports and no one participant will be identifiable in the final documents.

3.9.1 Autonomy

Participants were given full details of the nature of the study and were free to withdraw at any time without any consequences. All participants in the study were assured of complete confidentiality and the study data obtained was kept secure. No companies were given individualised data so as to protect individual participants' identity.

3.9.2 Benefit

After the analysis, the results could have a population benefit in terms of understanding recall of GHS hazard information which could contribute to improvement of GHS training and implementation in South Africa.

3.9.3 Harms/risks

Due to the nature of the study the participants were not faced with any harms. All participants were free not to answer questions which they were not comfortable with, or withdraw from the study at any time. Current analysis will not require further participant involvement, therefore there will be no future harms.

3.9.4 Justice

The benefits of the research will be disseminated through journal publications as scientific literature. A copy of the report will also be made available at the University of Cape Town Medical School Library.

4. LOGISTICS

4.1 Work plan for 2015

Activity/Time	January	February	March	April	May	June	July	August
Protocol development								
Structured Lit review								
Data analysis								
Manuscript development								
Final thesis prep & submission								

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PART B: STRUCTURED LITERATURE REVIEW

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1. INTRODUCTION

The purpose of a hazard warning is to provide and remind users of relevant hazard information and to promote safety behaviours (Laughery, 2006; Laughery & Wogalter, 2014). It is crucial that hazard information for toxic substances be clearly presented and understandable in order to be effective in alerting users of potential hazards and how to safely use the product. Chemical hazard communication is commonly provided in the form of labels and safety data sheets (SDS) (London & Rother, 2003). Chemicals may have different properties with varying degrees of hazards as they may be flammable, corrosive, explosive, toxic or harmful to the environment. It is important for users to understand the potential hazards that are displayed on the warning labels due to high chemical exposure risks. The Globally Harmonised System of Classification and Labelling of Chemicals (GHS) aims to harmonise chemical hazard communication with the goal of improving comprehension and therefore the effectiveness of the information communicated (Rother & London, 2008; GHS, 2013; Dalvie et al., 2014). Comprehension of information requires higher order thinking and the ability to grasp information. Harmonisation of the information contained on labels and SDS is intended to provide consistent information, which in turn, promotes better comprehension and recall of chemical hazard information. The GHS may also provide an outline for Low and Middle Income Countries (LMIC) that may not have a chemical hazard communication system in place.

Recall can be defined as the process of retrieving words or pictures from memory (Houts et al., 2006). Recall of hazard information, such as the GHS information, is the first step to

comprehension and is very important in order for warnings and precautionary information to be effective (Houts et al., 2006; Lesch, 2008b). Failure to recall hazard information during a critical moment when the source of this information is not accessible can likely lead to injury or toxic exposures to a hazard. The recall of information is a cognitive process which is likely to differ between people and for different types of warnings and therefore it is important to understand what factors impact on recall.

2. LITERATURE REVIEW

2.1 Objective

Since comprehension and recall are closely linked, the purpose of this literature review is to identify themes as well gaps within the literature with respect to the comprehension and recall of hazard information. Firstly, I will explore the comprehension of chemical hazard information among students, workers and consumers in developed and developing countries. I will evaluate what is recommended in the literature to improve comprehension, which may also improve recall. Lastly, I will synthesise the demographic predictors of comprehension and recall of warning information found in the literature as I hypothesize these impact significantly on recall. The terms comprehension and understanding will be used interchangeably.

2.2 Search strategy

Literature was gathered from both online and print peer reviewed journals. The key databases used for searching literature were EBSCO host via academic search premier, Africa wide information via EBSCO host, Biosis - abstracts, Google Scholar, ScienceDirect, Medline, Scopus and PubMed. The search terms used included (comprehension) AND (memory OR recall) AND (labels OR labeling OR safety data sheets) AND (warning information OR warning design) AND (pictograms OR graphics) AND (demographics OR gender OR age

OR education OR training) AND (transport OR industry OR agriculture OR consumer) AND (developed countries OR developing countries) AND (GHS). Data from all study designs and countries were considered. As this research is a sub-study of a larger study, (London et al., 2003), the reference list of a previously published study, (Dalvie et al., 2014), was also used to obtain literature.

There are less than 10 studies that specifically investigated the recall of hazard information generally or the GHS specifically. However, since comprehension and recall are both cognitive processes I describe the findings of studies that investigated comprehension from which I made inferences about recall. Thereafter I described the findings of studies that specifically investigated recall. These processes are likely to be connected since comprehension is presented in the literature as enabling a person to recall information (Sundar et al., 2012).

2.3.1 Comprehension of chemical hazard information among users of chemicals

Previous studies have shown that the comprehension of hazard information for chemicals is low among those who are most exposed to hazardous chemicals (Adane & Abeje, 2012; Banda & Sichilongo, 2006; Boelhouwer et al., 2013; Rother, 2008). For instance, in a study of 83 chemistry and biology undergraduate students at Jimma University in Ethiopia, the majority (56.8%) were not familiar with hazard warning signs of laboratory chemicals (Adane & Abeje, 2012). The low familiarity with hazard information among undergraduate students was said to have been due to the fact that most of the symbols were difficult to understand and that they were not guided to pay attention to the warning labels. It should, however, be noted that students may not be comparable to workers since they do not work with hazard information on a daily basis. A publication presenting descriptive information of

a study of South African consumers and workers, who were regularly exposed to chemicals, also showed low levels of comprehension of hazard communication mechanisms such as GHS compliant labels (Dalvie et al., 2014). This could imply that there was insufficient training on the use of safety information. Only three out of twelve warning symbols were found to have more than 50.0% correct responses, namely, skull and crossbones (81.0%), flammable (61.0%) and explosive symbols (54.0%) (Dalvie et al., 2014). In another South African study of 115 farm workers in the Western Cape who were exposed to pesticides, more than half (52.0%) did not know about the pesticide label which contained the United Nations Food and Agricultural Organisation (FAO) warning and advice pictograms (Rother, 2008). Of the ten pictograms examined, only one was found to have more than 50.0% correct responses, namely, wear gloves (74.8%). A study of 150 Malaysian industrial workers showed a difference in the comprehension of GHS label symbols with the flammable symbol (99.3%) well understood and the compressed gas (27.3%) poorly understood (Ta et al., 2010). Similarly, in the South African study on consumers and workers the skull and crossbones (98.0%) and flammable (93.0%) symbols were well understood whereas the least understood were the corrosive and compressed gas symbols (>5.0%) (Dalvie et al., 2014). Therefore, since these two studies found a similar comprehensibility pattern with regards to the most and least understood symbols it is crucial to understand what factors impacted on comprehension. Lehto (1998) showed a 15 minute video about chemical safety and use of labels to engineering students from Purdue University in the United States of America (USA), after which they completed a questionnaire. It was found that the comprehension of labels was correlated with the ease of finding the information on the label (r=0.71), which was measured by rating scales (couldn't find anything on the label/found some/found everything). The low levels of comprehension among different users, the variability in the comprehensibility of different hazard symbols, familiarity of labels and chemicals as well as the ease of finding

information on the hazard communication instrument will most likely impact the recall of hazard information.

2.3.1.1 The impact of training on the comprehension of hazard information

In a study conducted by Adane & Abeje (2012), low comprehensibility amongst students and workers in Ethiopia was found to be associated with low levels of training. Comprehensibility was assessed when respondents were asked to match chemical properties with hazard signs. A study conducted by Lesch (2003), in the USA, investigated the impact of training methods on the comprehension of symbols. Participants were recruited through advertisements in local newspapers who were trained to comprehend symbols such as those for 'biohazard' or 'cancer-causing substance'. The training involved familiarising the participants with the name of the symbol and a sentence describing the symbol, and then describing to participants an accident scenario relevant to the symbol. When participants were tested after training, comprehension dramatically improved especially among the younger participants aged between 18 and 35 years (88.0% correct) compared to the older participants aged between 50 and 67 years (68.0% correct) (Lesch, 2003). When Lesch (2008a) repeated a similar study a few years later, it was found that training improved comprehension, however, there was no difference in comprehension between the younger participants aged between 20 and 35 years (43.0% correct) and older participants aged between 50 and 70 years (41.0% correct) (Lesch, 2008a). These studies indicate that training improves comprehension, although the increase in the Lesch (2008) study is far from ideal in a work hazard situation. The influence of age on symbol comprehension is unclear. It is likely that the effectiveness of training and age on comprehension of hazard information also influences recall of hazard information.

2.3.1.2 The effect of demographic factors on the comprehension of hazard information

Colour blindness and demographic characteristics such as age, gender and level of education has been identified as influencing comprehension of warning information since these may

influence cognition (Wogalter et al., 2002; Laughery, 2006; Laughery & Wogalter, 2014). A survey of four target sectors (agricultural, industrial, transport and consumer) in Zambia found that the level of education, gender and age did not influence the comprehension of GHS label elements, such as the colours, signal words and symbols (Banda & Sichilongo, 2006). In the latter study, the only means of assessing comprehension was by respondents ranking the label elements in the order of the most danger implied (for example, harmful-warning-caution-attention). Although, the Banda & Sichilongo (2006) study investigated a broad range of users, the demographic characteristics regarding the level of education and age were not clearly presented. In contrast, a study on 150 Malaysian industrial workers showed (using the Fisher's Least Significant Difference test which is a set of individual t-tests) that a tertiary level education improved the comprehension of GHS symbols compared to those who only completed secondary or primary school (Ta et al., 2010). However, a weakness of the Fisher's Least Significant Difference test is that it provides no protection against Type I error. This study also found that a higher position in the workplace led to a better comprehension of GHS symbols, whereas gender and age did not contribute to the comprehension of symbols. However, it must be noted that the majority of the participants were male (92.0%) and between 20-49 years of age. In the South African study on 115 Western Cape farm workers, males had more correct responses than females for nine out of the ten FAO pictograms in the study (Rother, 2008). This was attributed to females associating the pictograms with a social or cultural context since few of the women received training on pesticide safety and what the pictograms actually mean. Therefore, it seems that there is an uncertainty regarding the role of education in determining comprehension and by extension recall of hazard information. These studies also did not find age to influence comprehension of hazard information and the effect of gender is unclear.

2.3.2 The effect of demographic factors on the recall of warning information

The level of education, gender and age have also been examined with respect to the recall of warning information. A meta-analysis of 48 studies, conducted between the years 1975 and 2001, on the effectiveness of warning labels showed that recall is not correlated with age (under 25: average correlation=0.37, CI: 0.28 to 0.45; over 25: average correlation=0.21, CI: 0.12 to 0.31) (Argo & Main, 2004). However, the studies in the meta-analysis were conducted on participants aged in their mid-thirties to forties so data on the effect of older age on recall is lacking. Also, details on the countries in which these studies were done were not provided. On the contrary, in 2008 a nationwide survey of two thousand randomly selected Ukrainian adults over the age of 18 investigated the role of text warnings on cigarette packs (Andreeva & Krasovsky, 2011). The sample was reported to represent the demographic and geographic profile of the country. The relationship between recall of warning elements and demographic characteristics was investigated using multivariate analysis. Recall was measured by asking the participants to describe the warnings and was noted as 'recalled' if they mentioned specific words on the cigarette packs. This study found that people who completed a higher level of education recalled more warnings. However, recall declined with increase in age and males were more likely to recall warnings.

2.3.3 The influence of pictograms and graphics on information recall

It has been suggested that pictures are noticed and recalled more easily than words (Davies et al., 1998; Wogalter et al., 2002; Houts et al., 2006; Boelhouwer et al., 2013). This is supported by findings from studies conducted in South Africa and Malaysia which showed that the pictogram was the most frequently recalled element on the label after giving it to the subject for one minute and then withdrawing it (Dalvie et al., 2014; Ta et al., 2010). These two studies used the GHS pictograms, and the skull and crossbones and the flammable symbol were found to be the most understood in both studies. Similarly, a study of Australian

smokers who were interviewed in four independent surveys from 2005 to 2008 found that the unprompted recall of graphic cigarette packet warnings increased significantly at each year surveyed (2005-0.0%, 2006-14.0%, 2007-9.0%, 2008-12.0%) (Miller et al., 2011). However, they also point out that unprompted recall of new graphics and its associated health beliefs is at its peak in the year that the warnings are introduced (2006, 14.0%). Therefore, new information attracted more attention and by extension, promoted better recall than old information, since in 2007 recall declined to 9.0%. These findings contradict the effect of the familiarity bias (familiar information is easily recalled). After prompting, 86.0% of smokers noticed the new warnings on the cigarette packet.

In comparison, the use of symbols or graphics in medication information did not enhance recall in a low health literate study population (King et al., 2012). Participants were from Jackson, Tennessee, USA and were recruited from the local literacy council and basic education programmes for adults. In order to assess the general literacy of potential participants, they were administered the Rapid Estimate of Adult Literacy in Medicine (REALM) test. The REALM is a measure for assessing reading ability by testing the pronunciation of medical words. This study was performed using an interviewer-administered questionnaire, whereby each participant was given one minute to review a leaflet and then questioned on their recall of the information. Despite the author's hypothesis that the inclusion of symbols would generate better recall in low health literate populations, they found that the symbols did not enhance short-term recall of information. A limitation in this study could be that the sample may have not been a ‘low literate sample’ since participants were able to read warning information. Another possible limitation in this study could be that the symbols that were used were not understandable. Therefore, the role of symbols on information recall is likely to depend on the comprehensibility of the pictogram.

2.3.4 The importance of warning design on comprehension and recall

Training, education, gender and age are not the only factors that may impact comprehension and recall of hazard information. Laughery (2006) has identified design and non-design factors important for the effectiveness of warning instruments. These design factors include size, location, colour, signal word and the use of pictorials and the non-design factors relate to the target audience and the specific context of the warning information. According to Wogalter et al., 2002, the most important factor for hazard information to be effective is that a warning needs to be clear and noticeable. There are also guidelines for assessing comprehension of symbols/pictograms. One source is the open-ended comprehension testing procedure outlined in ANSI Z535.3. In this regard, the presence of pictorials improved the recall of warnings. In a study of 54 Turkish military pilots, it was found that when symbols were included on warnings used in flight manuals, the symbols contributed to the effectiveness of a warning (Erdinc, 2010). This was established by a test whereby participants were asked to match a designed symbol to a warning message. In the latter study, the comprehension levels of the skull and crossbones symbol and the plane with a broken wing symbol were high (>85.0%). The fact that the participants were military pilots who are well educated and aged 24-38 years may have accounted for the high level of comprehension. In another study on the inclusion of pictograms in warnings, Boelhouwer et. al. (2013) administered questionnaires to 90 undergraduate students from Auburn University (naive chemical users) and 45 members of selected professional societies including the Society for Chemical Hazard Communication, the American Industrial Hygiene Association, and the American Society of Safety Engineers (expert chemical users). Two versions of a safety data sheet (SDS) were created for two unnamed chemicals, one with GHS pictograms plus text and one with text only. On separate occasions, participants were asked to answer questions regarding both versions of the SDS. They found that the inclusion of pictograms on SDS

significantly decreased the time to respond to the questions in both the naive and expert chemical users. However, all the participants in this study were literate implying that they were able to read the text regardless of the pictogram. In contrast, Rother (2008) found that Western Cape farm workers relied on their cultural and socio-economic background to interpret FAO pesticide pictograms on pesticide labels. The meanings they attributed to the pictograms were not linked to the intended definition but were rather from their environment due to their lack of training. Similarly, a study of 31 trade and industry workers selected from a marketplace in Accra-Tema, Ghana examined the comprehension of symbols which are commonly used in the USA (Smith-Jackson & Essuman-Johnson, 2002). The symbols were tested without an attached context by asking participants what they meant. Only two out of the six symbols elicited more than 50.0% correct responses, namely, skull and crossbones (81.0%) and prohibition (58.0%). This highlights the difficulty in cross-cultural interpretations of symbols and the non-design factor (i.e. context) which is crucial in designing warning information. Nevertheless, these studies demonstrate that pictograms is a design factor which appears to be vital for the comprehension and recall of hazard information, taking into consideration the context in which the information will be accessed.

2.4 Gaps in the literature

This literature review has shown that there is minimal literature on the recall of chemical hazard information, especially on the effect of demographic characteristics. Previous studies have found generally inconsistent results on the effect of education, training, gender and age. However, since it is crucial that the content of warning information be read and understood, studies investigating the role, if any, of the chemical users sector (industrial, transport or agriculture), speaking and reading ability of English and Afrikaans, vision, occupation as well as further examining the effect of education, training, gender and age are required. Further investigation of the effect of design and non-design factors on recall should be

examined as well as studies from different regions of the world to compare contextual differences. Further studies are also needed to estimate the effect of training on the comprehension and recall of hazard information in a low literate populations of chemical users (e.g. domestic workers), as is more common in LMIC. Also, other predictors of recall need to be examined in order to determine strategies to improve the recall of hazard information.

3. CONCLUSION

This review indicates that the level of education, previous training and the inclusion of pictograms on the hazard communication material are all factors which contribute to the recall of hazard information. The influence of gender and age on recall is incongruent and remains to be explored. More literature is required on the demographic predictors of the recall of hazard information, the effect of design and non-design factors on recall, the effect of training on the recall among low literate populations and the examining of different regions or contexts.

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PART C: JOURNAL READY MANUSCRIPT

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Demographic determinants of chemical safety information recall in workers and consumers in South Africa.[1]

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ABSTRACT

Chemical hazard communication is intended to alert users of the potential hazards of chemicals. Apart from the fact that hazard information should be understood, it is also important that it should be recalled. Recall of hazard communication is critical when the written form of the information is not available at the time it is required. A cross-sectional study investigating predictors of the recall of chemical safety information on labels and safety data sheets amongst 315 workers (industry, transport and agriculture sectors) and 87 consumers in two provinces of South Africa was conducted. The recall of participants was tested using two modules (module 2 which relates to the demographics, and module 3 which relates to the recall of the participants) from the Hazard Communication Comprehensibility Testing (CT) Tool developed by the Centre for Environmental and Occupational Health at the University of Cape Town. Respondents were predominantly male (67.7%), the median age was 37 years (IQR: 30-46 years) and less than half of the participants completed high school (47.5%). The majority of participants were blue collar workers outside of industry (55.5%). The skull and crossbones symbol was the label element most recalled, both unprompted (79.6%) and prompted (94.8%), and the first aid and treatment measures the least frequently recalled (6.0%-29.9%). Multivariate analysis showed the predictors that were found to increase the recall of all the label elements were, industrial sector, transport sector, agriculture sector, gender, home language English and Afrikaans, reading English and Afrikaans, completing high school and non-industry white collar occupations. The predictors that were found to decrease recall were further education, not wearing glasses and non-industry blue collar occupations. This study found demographic factors to influence the recall of hazard information. Policy should ensure the implementation of procedures that promote the recall of hazard information to protect workers from hazardous exposures.

1. INTRODUCTION

Chemical hazard communication is intended to alert users of the potential hazards of chemicals in order to promote safe behaviours to prevent harmful chemical exposures. Apart from the fact that hazard information should be understandable, it is also important that it should be recalled which means that hazard words or pictures should be able to be retrieved from memory (Houts et al., 2006). Recall of hazard communication is critical when the written form of the information is not available at the time it is required. Consumers and workers in the industrial, transport and agricultural sectors have high chemical exposures but may not have regular access to hazard information, which highlights the importance of information recall in order to prompt safe behaviours during chemical use and to prevent injury or toxic exposure.

In order to harmonise chemical hazard communication, the Globally Harmonised System of Classification and Labelling of Chemicals (GHS) was endorsed in 2002 by the United Nations Committee on Experts on the Transport of dangerous goods (UNCETDG) (Rother & London, 2008; GHS, 2013). The GHS aims to promote human and environmental safety, facilitate international trade of chemicals and provide adequate information on chemicals (Rother & London, 2008; Dalvie et al. 2014). This harmonisation of information that is contained on labels and safety data sheets (SDS) is perceived to provide standardized information which in turn promotes better comprehension and recall of chemical hazard information.

Warning labels are comprised of different elements to communicate the hazard and precautionary information. This assists users with different levels of literacy as well as to

draw attention to crucial information. There are no previous studies which have examined the effect of demographic factors on the comprehension and recall of individual chemical warning label elements. Recall is likely to be connected to the comprehension of information since comprehension enables a person to recall information (Sundar et al., 2012). Previous studies have shown that the comprehension of hazard communication for chemicals is low among those who are exposed to hazardous chemicals (Adane & Abeje, 2012; Banda & Sichilongo, 2006; Boelhouwer et al., 2013; Dalvie et al., 2014). A previous publication presenting descriptive information of a study investigating comprehensibility and recall of hazard information among workers and consumers in South Africa, found only three out of twelve symbols to have more than 50.0% correct responses, namely, skull and crossbones (81.0%), flammable (61.0%) and explosive symbols (54.0%) (Dalvie et al., 2014). Dalvie et al. (2014) and Adane & Abeje (2012) also found that low comprehensibility correlated with low levels of training which was prevalent across a range of chemical users in South Africa and Ethiopia. An earlier study conducted in the United States of America found that training dramatically improved comprehension (Lesch, 2003). Previous studies investigating the effect of demographic factors on recall and comprehension has shown that education increased recall, position in the workplace improved comprehension and there are inconsistent findings on gender and age. The study by Lesch (2003) found comprehension to be greater among the younger participants aged between 18 and 35 years (88.0% correct) compared to the older participants aged between 50 and 67 years (68.0% correct). A survey of four target sectors (agricultural, industrial, transport and consumer) in Zambia found that the level of education, gender and age did not influence the comprehension of label elements (Banda & Sichilongo, 2006). The level of comprehension varied among sectors including agriculture (33.0%), transport (37.0%), industry (69.0%) and consumers (15.0%). However, a study conducted in Malaysia found that tertiary level education and a higher position in the

workplace improved comprehension of symbols (Ta et al., 2010). Additionally, a study in Ukraine found recall of warnings increased with education, declined with age and was greater in men (Andreeva & Krasovsky, 2011). Previous studies have also found that the pictogram to be the most frequently recalled label element, with the skull and crossbones and flammable symbol being the most recognised (Dalvie et al., 2014; Ta et al., 2010).

Further research on the effect of education, training, gender and age on recall and comprehension of hazard information as well as research on other factors impacting effectiveness of hazard information is therefore required. This study will investigate factors determining the recall of safety information amongst workers and consumers in two provinces of South Africa.

2. MATERIALS AND METHODS

Institutional Review Board (IRB) approval for the study was granted by the University of Cape Town's Human Research Ethics Committee (HREC REF: 279/2015) A copy of the approval letter is attached (Appendix D).

2.1 Study design

This study is part of a larger cross-sectional analytic study that investigated the comprehensibility of chemical hazard communication tools developed by the University of Cape Town amongst 402 workers and consumers in the Western Cape and Gauteng provinces of South Africa (London et al., 2003; Dalvie et al., 2014). The four sectors of chemical users investigated were industry, transport, agriculture and consumers.

2.2 Study population

The main study (London et al., 2003; Dalvie et al., 2014) was intended to provide a snapshot view of the comprehensibility of chemical hazard information to support the implementation of the GHS in South Africa. The study population was therefore taken to reflect employees with potential exposure to chemicals (e.g. farmers, factory workers) as well as consumers who are likely to be affected (e.g. hairdressers).

2.3 Sampling

The aim was to include 100 subjects from each sector, with 50 each from the Western Province and Gauteng (London et al., 2003). Within the four sectors, there were different types of sampling procedures and participants were stratified accordingly. Chamber of Commerce lists from 2003 were used as the sampling frame for the industrial and transport sectors. In general, the goal for every workplace sampled was to include a range of production workers, shop stewards/safety representatives, managers/supervisors and technical (e.g. laboratory) staff. If a company declined to participate, or did not respond, one substitution was allowed from the company next on the list. However, even after an allowed substitution, the substituted company may not have participated. This non-participation differed across sectors and sub-sectors, resulting in different sample sizes for each province.

Industrial site

The industrial sector included workers, managers, factory supervisors and laboratory scientists. The sample included a chemical stratum (users and generators of chemicals such as laboratory workers) and non-chemical stratum which consisted of a combination of Standard Industrial Classification categories (mining, paper, textiles, electricity, gas and water, construction, wholesale and retail trade, health care, domestic works, and cleaning industries) and was about twice the size of the other sectors. The strata were further categorized by

company size which was determined by the number of employees (small = < 20 employees; medium = 20 to 199 employees; large = >200 employees).

Transport

The transport sector included road, rail, air and sea transport. It was stratified by companies exclusively involved in transport and companies who maintained transport fleets (e.g. petroleum). The strata were further categorized by company size which was determined by the number of employees (small = < 20 employees; medium = 20 to 199 employees; large = >200 employees).

Agriculture

The agricultural sector included farm workers, managers and other related agricultural workers. Due to limitation in access, farms were selected by opportunistic sampling and were stratified by large commercial farming, small commercial farming and emergent farmers.

Consumer

Consumers were sampled by opportunistic sampling from supermarkets, laundromats, hairdressers and hardware shops. They were stratified by urban and rural consumers.

The final sample realised for all sectors is shown in Table 1 below.

Table 1: Sample from each province (N=402)

	Cape Town n (%)	**Gauteng n (%)**	**Total n (%)**
Industry (chemical)	62 (15.4)	24 (6.0)	86 (21.4)
Industry (non-chemical)	63 (15.7)	27 (6.7)	90 (22.4)
Transport	44 (10.9)	28 (7.0)	72 (17.9)
Agriculture	55 (13.7)	12 (3.0)	67 (16.7)
Consumer	67 (16.7)	20 (5.0)	87 (21.6)
TOTAL	**291 (72.4)**	**111 (27.6)**	**402 (100.0)**

2.4 Questionnaire

The Hazard Communication Comprehensibility Testing (CT) Tool developed for testing comprehensibility of the GHS was used in the main study (London et al., 2003). The tool consisted of seven test modules that comprised of questionnaires and procedures specifically designed to test the comprehension of hazard communication material. For this sub-study only data generated from module 2 which relates to the demographics, and module 3 which relates to the recall of the participants are described.

Labels were specifically designed for the study in English, and were based on real chemicals (e.g. acetone, cholorpyrifos). The labels carried hypothetical brand details (such as trade names, manufacturer, address, contact details, etc.) to avoid situations where workers familiar with a particular chemical perform better than others because of familiarity.

2.4.1 Pilot study

The tool was evaluated in a pilot study conducted in Zambia in June 2002, with the support of the United Nations Institute for Training and Research (UNITAR) and with consultant support from the Centre for Environmental and Occupational Health Research (CEOHR) at UCT. Based on this piloting, the modules were shortened, questions were changed and reorganised. Also, a manual to accompany the questionnaires was compiled as a guide for the interviewers. Following tool refinement, there was further piloting on a convenience sample of 10 to 15 subjects (drawn from the targeted sectors) in the Western Cape region.

2.4.2 Recall relevant modules

Of the seven modules, module 2 and 3 were identified as relevant for testing recall. For module 2, participants were administered a face-to-face demographic questionnaire (items included information on gender, education, employment details and work experience) and a test for visual acuity (using Ishihara plates) and colour blindness (using Snellem's E). For

module 3, one of two labels were randomly selected by the interviewer, either *Saloc* or *Bayetone*. The participants were provided with the label and they were allowed to look at it for 60 seconds after which it was taken away from them. They were then questioned on their familiarity with the label, for example, whether or not they have seen it before. Thereafter, they were asked what they could remember on the label. This is referred to as unprompted recall. The label elements that were recalled were marked off and the remainder of the label elements were mentioned and they were asked if they remembered it, this is referred to as prompted recall.

2.4.3 Questionnaire administration

The questionnaires in modules 2 and 3 were administered in the form of face-to-face interviews by trained interviewers in the spoken language of the interviewee (i.e. English, Afrikaans, IsiXhosa, Tswana, Sotho, IsiZulu). Companies provided appropriate venues to interview workers, while consumers were interviewed in malls, or in venues provided by supermarkets and shops. Domestic workers were interviewed in private homes, as were employers of domestic workers.

2.4.4 Outcome measures

The primary outcome measure for this sub-study was recall which has been operationalised as a dichotomous variable (Yes/No). Both prompted and unprompted recall was analysed with respect to its relationship with the predictor variables including; province, gender, age, high school, further education, sector, no glasses when tested, colour blindness, training, home language English, read English, home language Afrikaans, read Afrikaans, non-industry blue collar occupations, managers, non-industry white collar occupations and industry blue collar occupations.

2.5 Statistical analysis

Analysis was performed using STATA version 12.1 (Stata corporation 2011).

2.5.1 Univariate analysis

Only age and the total recall score were continuous variables, therefore the means and medians for these are reported. The other variables are dichotomous for which the frequencies are presented and discussed.

2.5.2 Bivariate analysis

Since the outcome variable (recall) was a dichotomous variable bivariate analysis included logistic regression to assess the association between the predictor variables and the outcome variables. Predictors with an association with recall (p-value was ≤ 0.1) were included in multivariate analysis. It was found that all the predictor variables were associated with one or more of the outcome variables. Therefore, all the predictor variables were considered in the model building process for the multivariate analysis.

2.5.3 Multivariate analysis

Multiple logistic regression (for dichotomous variables) and linear regression (for the recall score) was performed to determine the predictors for each recall variable using a stepwise forward selection model building strategy. To do this we started with an empty model then included one predictor at a time. At each step we assessed whether the variable included significantly improved the model by looking at the log likelihood ratio test. This was an iterative process completed until no additional variable significantly improved the model. Only significant associations from the final models were represented in the results.

3. RESULTS

3.1 Descriptive information

3.1.1 Demographic information, vision, employment and training

Most of the participants (72.4%) were from the Western Cape (Table 2). They were also predominantly male (67.7%) and the median age was 37 years (IQR: 30-46). The majority of the interviews were conducted in English (74.1%). The participants' home languages were mainly Afrikaans (36.2%) followed by English (32.9%). Less than half of the sample completed high school (47.5%) and 43.1% of these sought further education after high school. Just over a third (37.3%) of participants reported usually wearing glasses, but less than a quarter of the participants (23.6%) had their glasses on when tested, thus resulting in 13.7% of participants with impaired vision. The majority of participants were blue collar workers outside of industry (55.5%), and in industry (25.4%). There were 49 white collar workers from industry of whom all were managers (12.2%) and 28 white collar workers from outside industry (7.0%). Almost half of the participants reported that they had received some form of training (48.8%) either in general health and safety, labels and chemical safety or safety data sheets and chemical safety.

Table 2: Demographic information, employment, training and vision (N=402)

Variable		n (%)
Province	Western Cape	291 (72.4)
	Gauteng	111 (27.6)
Sectors	Industry	176 (43.8)
	Transport	72 (17.9)
	Agriculture	67 (16.7)
	Consumer	87 (21.6)
Gender	Male	272 (67.7)
	Female	130 (32.3)
Marital Status	Married	275 (68.4)
Children	Have children	317 (78.9)
Language		

Language of interview	English Afrikaans IsiXhosa Tswana Sotho IsiZulu Others	298 (74.1) 58 (14.4) 22 (5.5) 1 (0.3) 12 (3.0) 9 (2.2) 2 (0.5)
Home language	English Afrikaans IsiXhosa Tswana Sotho IsiZulu Others	132 (32.9) 145 (36.2) 52 (13) 11 (2.7) 22 (5.5) 20 (5.0) 20 (5.0)
Read	English Afrikaans	363 (90.3) 332 (83.6)
Educational status		
School attendance	Non or primary school High school	209 (52.6) 189 (47.5)
Further education	After school	169 (43.1)
Acuity and colour blindness		
Usually wear glasses Wore glasses when tested Did not wear glasses when tested (impaired vision)	150 (37.3) 95 (23.6) 55 (13.7)	
Colour blind	47 (11.7)	
Employment and training		
Occupation	Non-industry blue collar [a]	223 (55.5)
	Managers [b]	49 (12.2)
	Non-industry white collar [c]	28 (7.0)
	Industry blue collar [d]	102 (25.4)
Any training in occupational health and safety	Male Female	119 (60.7) 77 (39.3)

a - driver, production worker, skilled worker, general worker, unemployed, domestic, stevedore, pensioner, driver assistant, cargo loader, family member, housewife, fire officer, sprayman
b - manager
c - student, health professional, lab worker
d - production worker, general worker, store operator, seafaring laborer, unskilled worker

3.1.2 Unprompted and prompted recall of label elements

The skull and crossbones symbol was the symbol and label element most recalled, both unprompted (79.6%) and prompted (94.8%) (Table 3). This was followed by the flammable symbols which also had a high percentage of recall after prompting (91.3%). Only half of the participants (50.0%) recalled the environmental hazard symbol, unprompted. However, this also increased after prompting (77.9%).

One hundred and sixty participants (39.8%) recalled the signal word, danger or warning, unprompted. The prompted recall increased to 82.3% (Table 3).

Less than half of the participants recalled individual hazard statements unprompted with hazard information the most frequently recalled (32.6%) and the statement 'may cause reproductive effects', recalled the least (5.0%) (Table 3). Prompting, however, increased recall of all but one hazard statement to over 50.0% of the sample with the statement, 'causes skin and eye irritation' the most frequently recalled (81.8%). Most of the participants recalled at least one of the hazard statements unprompted and prompted (83.6% and 96.5% respectively).

Individual first aid and treatment measures were also poorly recalled unprompted with the most frequently recalled item 'flush eyes or skin with water' recalled by 29.9% of the participants (Table 3). Prompting, however, increased recall of all individual first aid measures to over 50.0% of the sample. The least recalled first aid item was 'remove contaminated clothes and shoes', unprompted (6.0%) and prompted (60.5%). Approximately half of the participants recalled at least one of the first aid measures (51.0%) unprompted, however this increased to 91.0% after prompting.

The median number of label elements (n=28) that each participant recalled unprompted was 5.5 (IQR: 4-8) and after prompting, this increased to 22 (IQR: 15-25).

Table 3: Unprompted and prompted recall of label elements (N=402)

	Unprompted n (%)	**Prompted n (%)**
Correct chemical name	118 (29.0)	243 (60.5)
Symbols		
Skull and crossbones symbol	320 (79.6)	381 (94.8)
Flammable symbol	263 (65.4)	367 (91.3)
Environmental hazard symbol	201(50.0)	313 (77.9)
Signal word		
Danger or Warning	160 (39.8)	331 (82.3)
Statement		
At least one of the hazard statements	336 (83.6)	388 (96.5)
Hazard information	131 (32.6)	320 (79.6)
Active ingredient acetone	90 (22.4)	265 (65.9)
Quart	128 (31.8)	128 (31.8)
Harmful or fatal if swallowed	82 (20.4)	320 (79.6)
Work in adequate ventilation	55 (13.7)	303 (75.4)
Avoid prolonged or repeated breathing of vapour	53 (13.2)	299 (74.4)
Causes skin and eye irritation	104 (25.9)	329 (81.8)
May cause reproductive effects	20 (5.0)	255 (56.0)
Emergency contact phone number	89 (22.1)	293 (72.9)
Use of protective clothing	98 (24.4)	303 (75.4)
Protect from freezing	25 (6.2)	208 (51.7)
First aid & treatment		
At least one of the first aid measures	205 (51.0)	366 (91.0)
Flush eyes or skin with water	120 (29.9)	310 (77.1)
Remove contaminated clothes and shoes	24 (6.0)	243 (60.5)
Remove to fresh air	31 (7.7)	256 (63.7)
Artificial respiration	41 (10.2)	271 (67.4)
If swallowed, do not induce vomiting	57 (14.2)	258 (64.2)
Give large amount of water	35 (8.7)	247 (61.4)
Causes skin and eye irritation	59 (14.7)	286 (71.4)
Difficult breathing, give oxygen	38 (9.5)	254 (63.2)
Empty, uncleaned drums are dangerous	55 (13.7)	259 (64.4)
Keep label until decontaminated	37 (9.2)	246 (61.2)

In case of emergency	52 (12.9)	278 (69.2)
Call appropriate services	49 (12.2)	281 (69.9)

3.2 Multivariate analysis of the relationship between the unprompted and prompted recall of the label elements and predictors

3.2.1 Correct chemical name

Gender, home language English and non-industry white collar occupations were significant predictors for unprompted recall of the correct chemical name (Table 4), while for prompted recall significant predictors were province, home language English and non-industry blue collar occupations (Table 5). Males were 70.0% more likely than females to recall the correct chemical name, unprompted (OR=1.7, CI: 1.0;2.9). Respondents whose home language was English were twice likely to recall the correct chemical name, unprompted (OR=2.0, CI: 1.2;3.2) and prompted (OR=2.1, CI: 1.3;3.5), compared to those whose home language was not English. Respondents who worked in non-industry white collar occupations were 2.3 times more likely to recall the correct chemical name, unprompted, compared to those who do not work in these occupations (OR=2.3, CI: 1.0;5.3). However, those who work in non-industry blue collar occupations were 40.0% less likely to recall the correct chemical name, prompted, compared to those who do not work in these occupations (OR=0.6, CI: 0.4;0.9).

3.2.2 Symbols

Province, industry and transport sectors, gender, further education and no glasses when tested were significant predictors for unprompted recall of the hazard symbols (Table 4), while for prompted recall significant predictors were gender, home language English, home language Afrikaans and no glasses when tested (Table 5). Participants from the industrial sector were 70.0% less likely to recall the skull and crossbones symbol (OR=0.3, CI: 0.2;0.7) compared to those from the other sectors (transport, agriculture and consumers), unprompted.

Table 4: Significant predictors of unprompted recall of label elements in multivariate analysis (odds ratios and regression coefficients*)

	Province	Industry	Transport	Agriculture	Gender	Home language English	Read Afrikaans	High school	Further education	No glasses when tested	Non-industry blue collar	Non-industry white collar
Correct chemical name					1.7 (1.0 ; 2.9)	2.0 (1.2 ; 3.2)						2.3 (1.0 ; 5.3)
SYMBOL												
Skull & crossbones	2.0 (1.1 ; 3.7)	0.3 (0.2 ; 0.7)										
Flammable		0.3 (0.2 ; 0.6)	0.3 (0.1 ; 0.6)						0.6 (0.4 ; 0.9)			
Environmental hazard	1.9 (1.2 ; 2.9)	0.6 (0.3 ; 0.9)	0.5 (0.2 ; 0.9)		2.0 (1.3 ; 3.3)				0.7 (0.4 ; 1.0)	0.4 (0.2 ; 0.8)		
SIGNAL WORD												
Danger/Warning	2.0 (1.2 ; 3.3)				1.8 (1.1 ; 2.9)							
HAZARD STATEMENT												
Work in adequate ventilation				0.1 (0.0 ; 0.6)								
Any hazard statement							2.4 (1.1 ; 4.9)	2.2 (1.1 ; 4.4)	0.3 (0.2 ; 0.7)	0.4 (0.2 ; 0.7)		
FIRST AID & TREATMENT												
Call appropriate services		3.4 (1.1 ; 10.3)	3.9 (1.2 ; 13.0)						0.5 (0.3 ; 1.0)			
Any first aid		2.5 (1.5 ; 4.3)	2.1 (1.1 ; 4.0)						0.5 (0.3 ; 0.7)			
Total recall*						1.7 (0.9 ; 2.4)			-2.0 (-2.8 ; -1.3)	-2.1 (-3.1 ; -1.1)	-0.9 (-1.6 ; -0.1)	

Province: Western Cape=1, Gauteng=0; Industry: Yes=1, No=0; Transport: Yes=1, No=0; Agriculture: Yes=1, No=0; Gender: Male=1, Female=0; Home language English: Yes=1, No=0; Read Afrikaans: Yes=1, No=0; High school: Yes=1, No=0; Further education: Yes=1, No=0; No glasses when tested: Yes=1, No=0; Non industry blue collar: Yes=1, No=0; Non industry white collar: Yes=1, No=0

Table 5: Significant predictors of prompted recall of label elements in multivariate analysis (odds ratios and regression coefficients*)

	Province	Industry	Transport	Agriculture	Gender	Home language English	Home language Afrikaans	Read English	Further education	No glasses when tested	Non-industry blue collar	Non-industry white collar
Correct chemical name	0.4 (0.3 ; 0.8)					2.1 (1.3 ; 3.5)					0.6 (0.4 ; 0.9)	
SYMBOL												
Flammable					2.3 (1.0 ; 5.3)	7.2 (2.1 ; 24.5)	4.1 (1.6 ; 12.0)					
Environmental hazard					1.9 (1.1 ; 3.2)					0.5 (0.3 ; 0.9)		
HAZARD STATEMENT												
Work in adequate ventilation									0.4 (0.2 ; 0.7)			
Any hazard statement								14.0 (3.6 ; 54.2)				
FIRST AID & TREATMENT												
Call appropriate services		1.8 (1.0 ; 3.3)	3.1 (1.4 ; 6.6)	2.2 (1.0 ; 4.6)				2.2 (1.0 ; 4.9)				5.8 (1.3 ; 26.7)
Any first aid									0.3 (0.1 ; 0.8)			
Total recall*	-1.5 (-3.1 ; 0.0)		2.3 (0.0 ; 4.7)						-2.3 (-3.6 ; -0.9)			

Province: Western Cape=1, Gauteng=0; Industry: Yes=1, No=0; Transport: Yes=1, No=0; Agriculture: Yes=1, No=0 ; Gender: Male=1, Female=0; Home language English: Yes=1, No=0; Home language Afrikaans: Yes=1, No=0; Read English: Yes=1, No=0; Further education: Yes=1, No=0; No glasses when tested: Yes=1, No=0; Non industry blue collar: Yes=1, No=0; Non industry white collar: Yes=1, No=0

Males were twice likely to recall the environmental hazard symbol compared to females, unprompted (OR=2.0, CI: 1.3;3.3) and prompted (OR=1.9, CI: 1.1;3.3). Respondents whose home language was English were 7.2 times more likely to recall the flammable symbol when prompted (OR=7.2, CI: 2.1;24.5), compared to those whose home language was not English. Those who did not wear glasses when tested were 60.0% less likely to recall the environmental hazard symbol, unprompted, compared to the other participants (OR=0.4, CI: 0.2;0.8). Respondents with a further education were less likely to recall the flammable symbol (OR=0.6, CI: 0.4;0.9) and the environmental hazard symbol (OR=0.7, CI: 0.4;1.0), compared to those with no further education, unprompted.

3.2.3 Signal word

Province and gender were significant predictors for the unprompted recall of the signal word (Table 4). Males were 80.0% more likely than females to recall the signal word, unprompted (OR=1.8, CI: 1.1;2.9).

3.2.4 Hazard Statement

The agriculture sector, reading Afrikaans, completing high school, further education and no glasses when tested were significant predictors for unprompted recall of the hazard statement (Table 4), while for prompted recall significant predictors were reading English and further education (Table 5). Those who worked in the agriculture sector were 90.0% less likely to recall the hazard statement ‘work in adequate ventilation’ compared to the other sectors (OR=0.1, CI:0.0;0.6), unprompted. Respondents who could read Afrikaans were more than twice likely to recall at least one hazard statement, unprompted, compared to those who could not read Afrikaans (OR=2.4, CI:1.1;4.9). Those who completed high school were also twice likely to recall at least one hazard statement, unprompted, compared to those who did not attend high school (OR=2.2, CI: 1.1;4.4). Respondents with a further education were 60.0% less likely to recall the statement, ‘work in adequate ventilation’ after prompting (OR=0.4, CI: 0.2;0.7). Those who did not wear glasses when tested were 60.0% less likely to recall any hazard statement, unprompted, compared to the other participants (OR=0.4, CI: 0.2;0.7). After prompting, those who could read English had a 14 fold increase in recalling any hazard statement compared to those who could not read English (OR=14.0, CI: 3.6;54.2).

3.2.5 First aid and treatment

Industrial sector, transport sector and further education were significant predictors for unprompted recall of first aid and treatment (Table 4), while for prompted recall significant predictors were industrial sector, transport sector, agriculture sector, read English, further education and non-industry white collar occupations (Table 5). Those who were from the industrial sector were more likely to recall the statement 'call appropriate services' compared to the other sectors, both unprompted (OR=3.4, CI:1.1;10.3) and prompted (OR=1.8, CI:1.0;3.3). Similarly, those from the transport sector were more likely to recall this statement compared to the other sectors both unprompted (OR=3.9, CI:1.2,13.0) and prompted (OR=3.1, CI:1.4;6.6). Respondents with a further education were less likely to recall at least one first aid and treatment measure, both unprompted (OR=0.5, CI:0.3;0.7) and prompted (OR=0.3, CI:0.1;0.8). Respondents who worked in non-industry white collar occupations were six times more likely to recall the statement, 'call appropriate services', compared to those who do not work in these occupations (OR=5.8, CI :1.3;26.7), after prompting.

3.2.6 Total number of label elements

Home language English, further education, no glasses when tested and non-industry blue collar occupations were significant predictors for unprompted recall of the total number of label elements (Table 4), while for prompted recall significant predictors were province, transport sector and further education (Table 5). Respondents whose home language was English recalled more of the label elements, unprompted, compared to those whose home language was not English (coefficient=1.7, CI: 0.9;2.4). Those who did not wear glasses when tested recalled less of the label elements, unprompted, compared to the other participants (coefficient= -2.1, CI:-3.1;-1.1). Respondents with a further education recalled less of the label elements compared to those without further education, both unprompted (coefficient=-2.1, CI: -2.8;-1.3) and prompted (coefficient=-2.3, CI: -3.6;-0.9). Those who worked in non-industry blue collar occupations recalled less of the label elements compared to the other occupations, unprompted (coefficient= -0.9, CI: -1.6;-0.1).

Therefore, the significant predictors for the unprompted and prompted recall of all the label elements were province, industrial sector, transport sector, agriculture sector, gender, home language English and Afrikaans, reading English and Afrikaans, completing high school, further education, not wearing glasses when tested, non-industry blue and white collar occupations. The predictors that were found to decrease recall were further education, not wearing glasses and non-industry blue collar occupations, with the remainder of the predictors increasing recall.

4. DISCUSSION

4.1 Chemical label elements

4.1.1 Correct chemical name

The reason why males were 70.0% more likely to recall the correct chemical name (Table 4) compared to females might be due to the fact that they have more training. A previous study on a nationwide survey on Ukrainian adults also found that males were more likely to recall warnings on cigarette packs because they smoked more than females (Andreeva & Krasovsky, 2011). In a South African study on 115 Western Cape farm workers, males had more correct responses than females for nine out of the ten FAO pictograms in the study which is probably due to lack of training among women (Rother, 2008). Those whose home language was English were more likely to recall the chemical name probably due to the fact that the warning information was written in English and indicating that participants who have a good understanding of the language are more likely to recall the information. There are eleven official languages in South Africa and Nicol & Tuomi (2007) have suggested that communication specialists need to be involved in training methods in order to cross the language barrier that exists. The findings indicate that recall was better amongst white collar workers (e.g., health professionals and laboratory workers) in general compared to blue collar workers (e.g., domestic and production workers) probably because white collar workers are better trained improving their ability to recall. This result is similar to that of a previous study which found that among Malaysian industrial workers, a higher position in the workplace improved comprehension of

GHS pictograms. This was probably the case because of attaining more work experience and it was expected that managers would have a better comprehension than those who work for them (Ta et al., 2010).

4.1.2 Symbols

The symbols were the most frequently recalled label element. This could be due to the fact that pictograms improve recall as indicated previously by other researchers (Wogalter et al., 2002; Erdinc, 2010; Boelhouwer et. al., 2013) because they are more easily noticed than words especially among those who are illiterate. The reason why those who work in the industrial and transport sectors were less likely to recall the symbols compared to those from the agriculture and consumer sectors could be because the latter group pays more attention to the symbols. The finding that a further education was not associated with the recall of the symbols is consistent with that of a previous study of four target sectors (agricultural, industrial, transport and consumer) in Zambia that also found that the level of education did not influence the comprehension of warning information (Banda & Sichilongo, 2006). However, Ta et al. (2010) found that a tertiary level education improved the comprehension of GHS symbols and Andreeva & Krasovsky (2011) found that a tertiary level education improved recall of cigarette pack warnings. Interestingly, despite symbols not containing any words, home language English and Afrikaans was associated with the recall of symbols. This might due to the fact that training or explanation of the symbol was administered in these languages. Males were found to have a better recall of the symbols and this is consistent with a study on 115 Western Cape farm workers where males had more correct responses than females for nine out of the ten FAO pictograms (Rother, 2008). This is probably because male farm workers received more training on how to read labels compared to females, similarly in this study 60.7% of males received any training compared to only 39.3% of females (Table 2). The lower recall among those who did not wear glasses (and indicated that they usually wear glasses) when they were tested is most likely because they had impaired vision and they were not able to see the symbols clearly.

4.1.3 Signal word

As with the recall of the correct chemical name, males were 80.0% more likely than females to recall the signal word (Table 4). This could again be because more males (60.7%) received training compared to

females (39.3%). A previous study also found that males were more likely to recall warning information on cigarette packs since they were more likely to be smokers which means they were more exposed to the warnings compared to non-smokers (Andreeva & Krasovsky, 2011).

4.1.4 Hazard statement

In order to recall the hazard statement which requires reading and understanding textual information, the ability to read English or Afrikaans (the language of the labels) plays an important role in recall. Also, being able to clearly see the chemical label in order to read and remember the safety information is paramount, therefore visual impairment decreases recall. As is the case for language, vision was not previously investigated in studies. Having a further education did not improve recall, however, those who completed high school had better recall compared to those who did not. This indicates that a high school education could be sufficient to equip chemical users with a level of literacy to be able to read and recall a hazard statement. This result is not consistent with that of Ta et. al. (2010) who found that a tertiary level education improved label hazard statement comprehension.

4.1.5 First aid and treatment

The poor recall of individual first aid measures (Table 3) could be due to chemical users directing their attention to the aspect of the warning label which prevents harmful exposure (e.g. hazard statement). Those who were from the industrial and transport sectors were more likely to recall the first aid and treatment measure compared to consumers and those in the agriculture sector perhaps because they are a literate group of workers who are more exposed to the information. As shown with the recall of the hazard statement, the ability to read English is essential in order to understand the text to promote recall. Once again, those among non-industry white collar occupations were more likely to recall the first aid and treatment measures indicating that students, health professionals and laboratory workers have a better recall of hazard information because they may be better trained.

4.1.6 Total number of label elements

The positive association between language and negative association with not wearing glasses indicates that being proficient in English and having clear vision enables reading and understanding of the label elements

which improves the recall of the information. Being educated beyond high school did not improve recall perhaps because the information on the chemical label is designed to be accessible to range of literacy levels. Once again, there is a lower recall among non-industry blue collar workers which is consistent with the finding that among Malaysian industrial workers, a higher position in the workplace improved comprehension (Ta et al., 2010).

4.2 Demographic characteristics which did not predict recall

This study found that the participants' age was not a predictor of the recall of any of the label elements, which corroborates the findings from previous studies (Argo & Main, 2004; Banda & Sichilongo, 2006; Ta et al., 2010). These findings on the impact of age on recall is probably attributed to the study participants' being in the younger age groups (30-46 years), and recall is expected to decline with age due to the deterioration of cognitive ability. Despite 12.0% of study participants tested positive for colour blindness, this was not a significant predictor for recall in this study. This study did not find that previous training significantly predicts the recall of the label elements which could be because the training was not specifically for the GHS labels that were used in this study. However, the better recall among males who have more previous training than females could indicate that training does in fact impact recall. Lesch (2003, 2008a) found that a training intervention improved the comprehension of warning information and a study by Adane & Abeje (2012) found that previous training improved comprehension of hazard information among students and workers with low levels of comprehension.

4.3 Effect of prompting on recall

Prompting increased the recall of all the label elements which is consistent with a previous study whereby prompting improved the recall of graphics on cigarette packets (Miller et al., 2011). The purpose of a warning is to act as a prompt to remind the user of the relevant hazard information. In instances when the warning information is not accessible, the prompting from those around the chemical user may also act as a reminder to promote recall in order to prevent harmful exposures and promote safe behaviours.

4.4 Limitations

A cross-sectional study design is merely a snapshot of the situation under investigation which limits our ability to make causal associations. An intervention study could be more effective in investigating the effect of training on recall. Only two provinces were included in the study and there were less participants from one of the provinces (Table 1). However, the two provinces included in the study are the ones with the largest industries and representing most of the major industries in the country. The fact that the labels were in English only may be regarded as a limitation however chemical warning labels are generally in the English language and the majority of the participants were able to at least read English.

5. CONCLUSION

This study found that symbols were the most frequently recalled label element and the first aid and treatment measures the least frequently recalled. The predictors that were found to increase the recall of chemical safety information among South African workers and consumers were, industrial, transport and agriculture sectors, gender, speaking and reading English or Afrikaans, completing high school and non-industry white collar occupations. The predictors that were found to decrease recall were further education, not wearing glasses and non-industry blue collar occupations.

In order to improve recall of hazard information, policy should require employers to ensure that their workers who are exposed to chemicals have adequate visual acuity by performing eye tests and ensure the use of glasses among those who should wear them. This will ensure that the safety information on the chemical label is visible in order to avoid harmful exposure. Hazard information should in the language understandable to workers and should be accessible to workers and consumers to explain what the symbols mean and what precautionary behaviour is needed with that symbol to reduce risks. Training of female workers should be improved. Policy should ensure that the safety information on chemical labels is clearly visible to read and understandable which will promote recall. GHS could also be taught in school since consumers are exposed to chemical hazard information.

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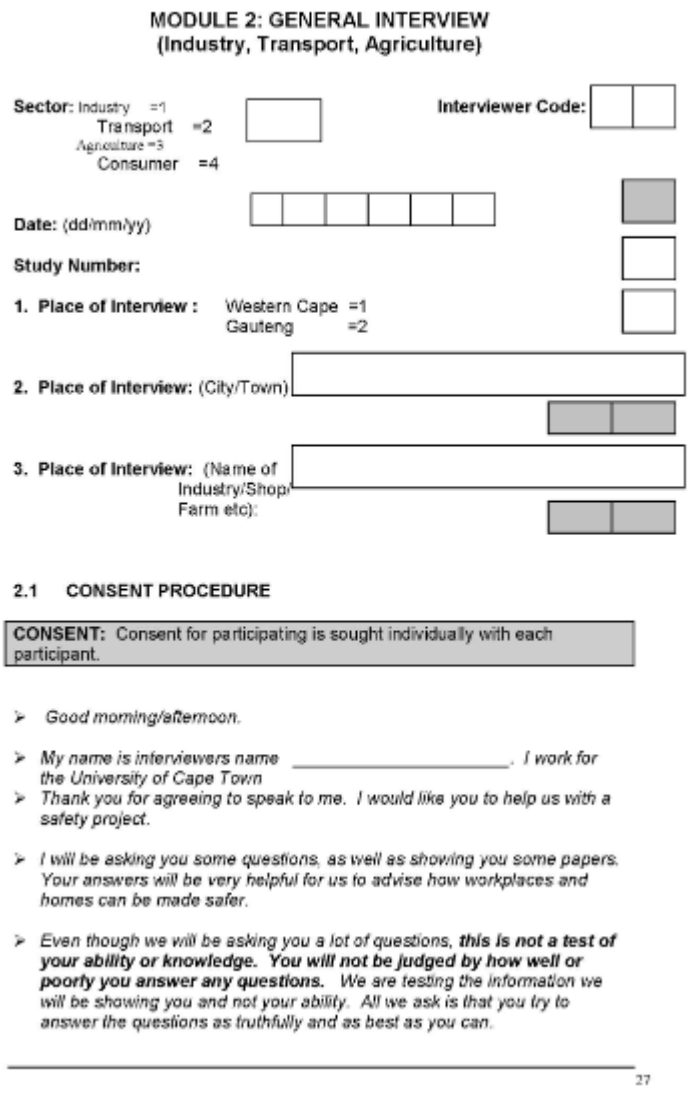
PART D: APPENDICES

APPENDIX A: MODULES 2 & 3



MODULE 2: GENERAL INTERVIEW
(Industry, Transport, Agriculture)

Sector: Industry =1
Transport =2
Agriculture =3
Consumer =4

Interviewer Code:

Date: (dd/mm/yy)

Study Number:

1. Place of Interview : Western Cape =1
Gauteng =2

2. Place of Interview: (City/Town)

3. Place of Interview: (Name of Industry/Shop/ Farm etc):

2.1 CONSENT PROCEDURE

CONSENT: Consent for participating is sought individually with each participant.

- *Good morning/afternoon.*
- *My name is interviewers name _____. I work for the University of Cape Town*
- *Thank you for agreeing to speak to me. I would like you to help us with a safety project.*
- *I will be asking you some questions, as well as showing you some papers. Your answers will be very helpful for us to advise how workplaces and homes can be made safer.*
- *Even though we will be asking you a lot of questions,* ***this is not a test of your ability or knowledge. You will not be judged by how well or poorly you answer any questions.*** *We are testing the information we will be showing you and not your ability. All we ask is that you try to answer the questions as truthfully and as best as you can.*

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- *There is no need to rush and you must not feel you have to impress us when you answer. Please remember that any information we collect will be kept anonymous and confidential. Nobody, other than the researchers (myself and my colleagues) will know how you answered any of the questions.*

- **READ TO WORKERS ONLY:**
- *Your participation will not affect your job and your supervisor/manager has agreed that you can participate. He/she knows that your answers will remain anonymous.*

- *It will take about 1 hour to conduct these interviews.*
- ***After you are finished we will give you an acknowledgement for your time spent with us and some safety information.***
- *Do you have any questions? We would be happy to answer them.*
- *Do you feel you understand why you are participating in this project? Are you happy to participate in this project?*
- *Thank you, we will now go ahead.* ***Remember****, even though you have said you are happy to participate, you do have the right to stop at any time if you so wish.*

Tick if respondent has verbally consented to participating in this study.	☐

2.2 RESPONDENTS' BIOGRAPHICAL INFORMATION

2.2.1 ***Gender*** **Male = 1 Female = 2** ☐

Date of Birth (dd/mm/yy) ☐☐☐☐☐☐

2.2.3 ***Are you married (or do you have a partner?*** **Yes =1 No =2** ☐

2.2.4 ***Do you have children?*** **Yes =1 No =2** ☐

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LANGUAGE

INTERVIEWER FILLS IN:

2.3.1 Language interview is conducted in: _____

2.3.2 ***What language/s do you speak at home?*** **: _____**

1= English	**4= Zulu**
2= Xhosa	**5= Tswana**
3= Afrikaans	**6= Sotho**
7= Other _____	

2.3.3 ***Language proficiency***

INSTRUCTION:
Code: **Proficient = 1; Partly Proficient = 2; Unable to speak/ read/write = 3**

Please tell me if you can …	***Read***	***Write***	***Speak***
Language of the interview			
Afrikaans			
English			

2.4 EDUCATIONAL STATUS

2.4.1 Have you attended school? **Yes =1 No =2** ☐

2.4.2 How much schooling have you completed? (Fill in appropriate number) ☐

- no formal schooling = 1
- formal schooling but never completed primary school = 2
- formal schooling, completed primary school but never completed secondary/high school = 3
- completed secondary/high school = 4

2.4.3 Did you receive any training, skills or further education after school? **Yes =1 No =2** ☐

2.4.3.1 **If yes, specify:** (Tick the appropriate box)

Have a diploma in a trained skill/vocation **Yes =1 No =2** ☐

Completed university, college of technical degree **Yes =1 No =2** ☐

Other (Specify): _____ ☐☐

2.4.3.2 *What is your occupation?*

_____ ☐☐☐

2.5 EMPLOYMENT DETAILS

2.5.1 ***Are you employed?*** **Yes =1 No =2** ☐

If **YES** go to 2.5.3

2.5.2 What do you do for a living?

_____

_____

_____ ☐☐

2.5.3 What is your current job title or occupation?

_____ ☐☐

2.5.4 Please describe what you do in your current job?

_____

_____ ☐☐

2.5.5 What type of industry do you work in?

_____ ☐☐

_____

6 WORK EXPERIENCE

2.6.1 ***Have you ever used or worked with the following?*** **Yes =1 No =2**

Vibrating tools (eg. Drill, jackhammer)	
Hot water	
Electrical Equipment	
Chemicals	
Heavy vehicles (e.g. trucks, tractor, forklift, crane)	

2.6.2 ***How would you find out about the hazards of a chemical you were working with?*** *(Tick the appropriate box – first unprompted, then prompt)*

FILL IN Yes =1, No =2, DK =3
Key: DK = don't know

Unprompted	Code	**Prompted**	Code
Label		*Label*	
SDS		*SDS*	
Co-workers		*Co-workers*	
Supervisors		*Supervisors*	
Training		*Go for Training*	
Occupational Health personnel		*Occupational Health Personnel*	
Other specialist personnel		*Other specialist Personnel*	
Trade Union office		*Trade Union office*	
Public information service (e.g. Poison Centre)		*Public information service (e.g. Poison Centre)*	
Other: (Specify)_____		*Other: (Specify)_____*	

2.6.3 ***If you use a chemical at work, what kind of information do you feel there should be on the chemical containers to protect your own health and safety?***

_____ ☐☐

_____ ☐☐

_____

2.7 ACUITY AND COLOUR BLINDNESS

INTERVIEWER:
- **For colour blindness tests: use Ishihara plates (Question 2.7.1)**
- **For visual acuity tests: use Snellem's E (Question 2.7.2).**

2.7.1 Test for Colour Blindness

Some people have difficulty seeing certain colours, although this does not cause problems for the person, this may be a problem when colour is used on products. We would now like to test you for colour blindness.

Respondent sees 8 + 29	=	not colour blind	Tick NO
Respondent sees 3 + 70	=	colour blind)	Tick YES

2.7.1.1. Is the respondent colour blind? **Yes =1 No =2** ☐

2.7.2 Test for Visual Acuity

3.7.2.1 Is the respondent wearing glasses **Yes =1 No =2** ☐

2.7.2.2 Do you usually wear spectacles/glasses? **Yes =1 No =2** ☐

We would also like to see how well you see from a distance

Can see at distance 6/12	Tick YES
Cannot see at distance 6/12	Tick NO

2.7.2.1 Does the respondent have adequate visual acuity (i.e., 6/12)?
Yes =1 No =2 ☐

- *Thank you very much for your effort.*
- *We will now proceed with the next set of questions.*

End of Module 2

MODULE 3: RECALL, READING AND COMPREHENSIBILITY OF LABELS

(For Transport, Industry and Agriculture Sectors)

BE SURE TO HAVE THE FOLLOWING BEFORE STARTING:

⇒ Stopwatch
⇒ Label SALOC (danger) =1 BAYETONE (Warning) = 2
⇒ Container

- **INSTRUCTION:**
- **Randomly select a label**
- **Time for 60s and take label back**

3.0 LABEL USED:

Label 3.1 **SALOC (Danger)** **= 1**
Label 3.2 **BAYETONE (Warning)** **= 2**

3.1 ATTENTION TO LABEL

- *I am going to ask you some questions.*
- *If you do not understand some of the words I use, I will explain them to you.*
- *Please do not be shy to ask me to explain the question to you.*
- *Please have a look at this. I am going to give you some time to look at this and I will ask you some questions about this*

INTERVIEWER FILLS IN: Time subject:

The respondent is allowed to look at the label for 60 seconds.

3.1.1 If subject looks at the label for 60s =1

3.1.2 If subject stops looking at the label before 60s =2

3.2 FAMILIARITY WITH THE LABEL

3.2.1 *Have you ever seen this before?*

(Point to the label) Tick the correct box

Yes =1	No =2	Not sure =3	☐

- *NB: If "YES", GO TO 3.2.2*
- *NB: If " NO" … EXPLAIN THAT THIS IS A LABEL (Do not ask 3.2.2)*

3.2.2 *What do you call this?* (Point to the label)

Label =1	Other name =2	Don't know =3	☐

- NB: TAKE BACK THE LABEL

3.3 RECALL

INSTRUCTION:

- Ask respondent what they can remember on the label - DO NOT PROMPT
- After you mark what they remember under 'without prompts' then proceed to ask if they remembered the items not mentioned under "prompted".
- Put answers on Table 3.3.

3.3.1 *What do you remember was on the label?* *[Tick appropriate box in Table 3.3 under "Unprompted" – 3.3.1]*

3.3.2 *Do you remember any of the following on the label?* *[Tick appropriate box in Table 3.3 under "Prompted" – 3.3.2]*

Table 3.3

3.3.1 3.3.2

		Without prompts Code=1	Prompted Yes =1 No =2
Identifier	1 BAYETON/BAYLOC		
	2 Other (specify)		
Symbols	3 		
	4 		
	5 		
	6 Other (specify)		
Signal Word	7 DANGEROUS / WARNING		
	8 Other (specify)		

Statement	9 Hazard Information		
	10 Active Ingredient Acetone		
	11 Quart: 32 Fl Oz		
	12 Harmful or fatal if swallowed		
	13 Work in adequate ventilation		
	14 Avoid prolonged or repeated breathing of vapour		
	15 Causes skin and eye irritation		
	16 May cause reproductive effects		

	17. In case of emergency call 021-93346867		
	18. Wear eye protection, suitable gloves and apron when handling this chemical		
	19. Protect from freezing		
First Aid & Treatment	20. In case of contact, immediately flush eyes or skin with water		
	21. Remove contaminated clothing and shoes		
	22. Remove to fresh air		
	23. If not breathing, give artificial respiration		
	24. If swallowed, do not induce vomiting		
	25. If conscious, give large amounts of water		
	26. Causes skin and eye irritation		
	27. If breathing is difficult, give oxygen		
	28. If not breathing, give artificial respiration		
	29. Empty, uncleaned drums can still be DANGEROUS		
	30. Keep labeled until decontaminated, only then remove label		
	31. IN CASE OF EMERGENCY		
	32. Call appropriate Emergency Services		
	33. Other (specify)		

INSTRUCTION: Return the label to the subject

- *Thank you. Here is the label again.*

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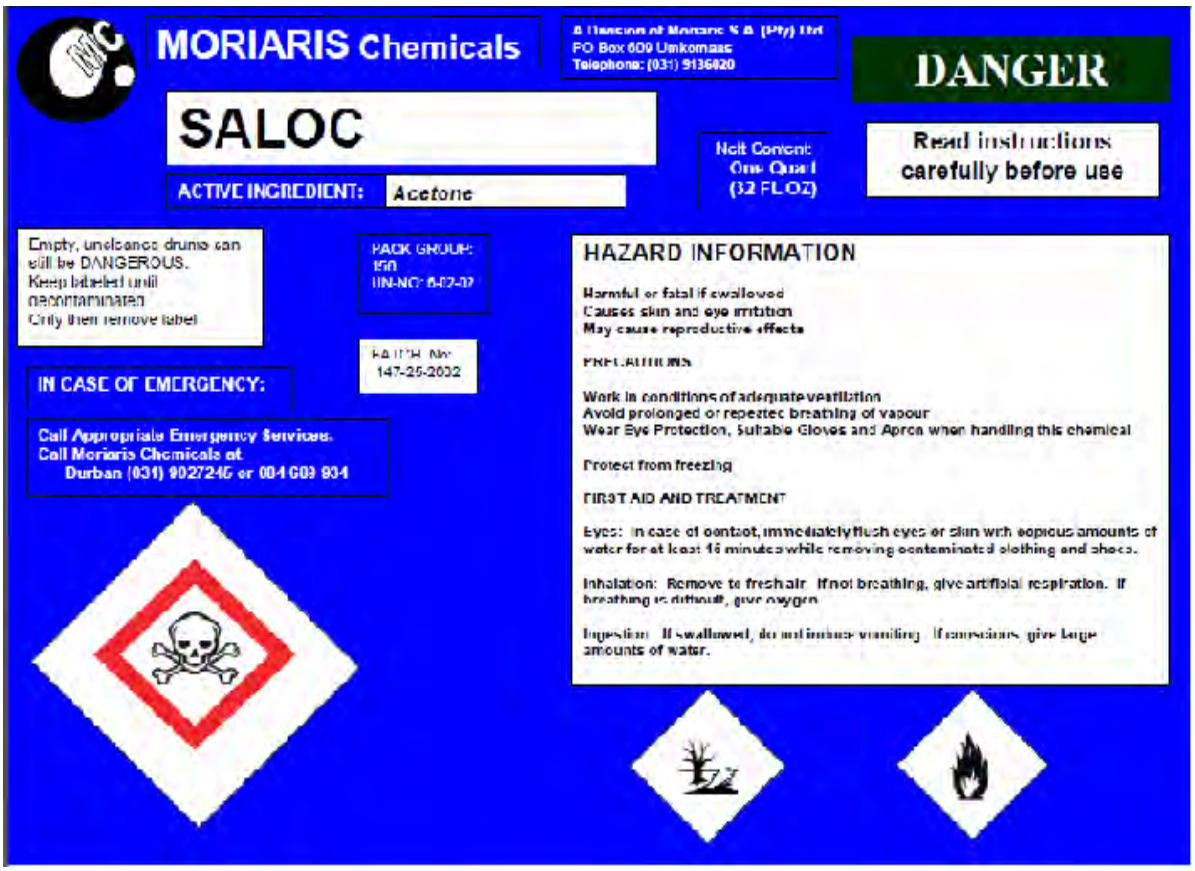
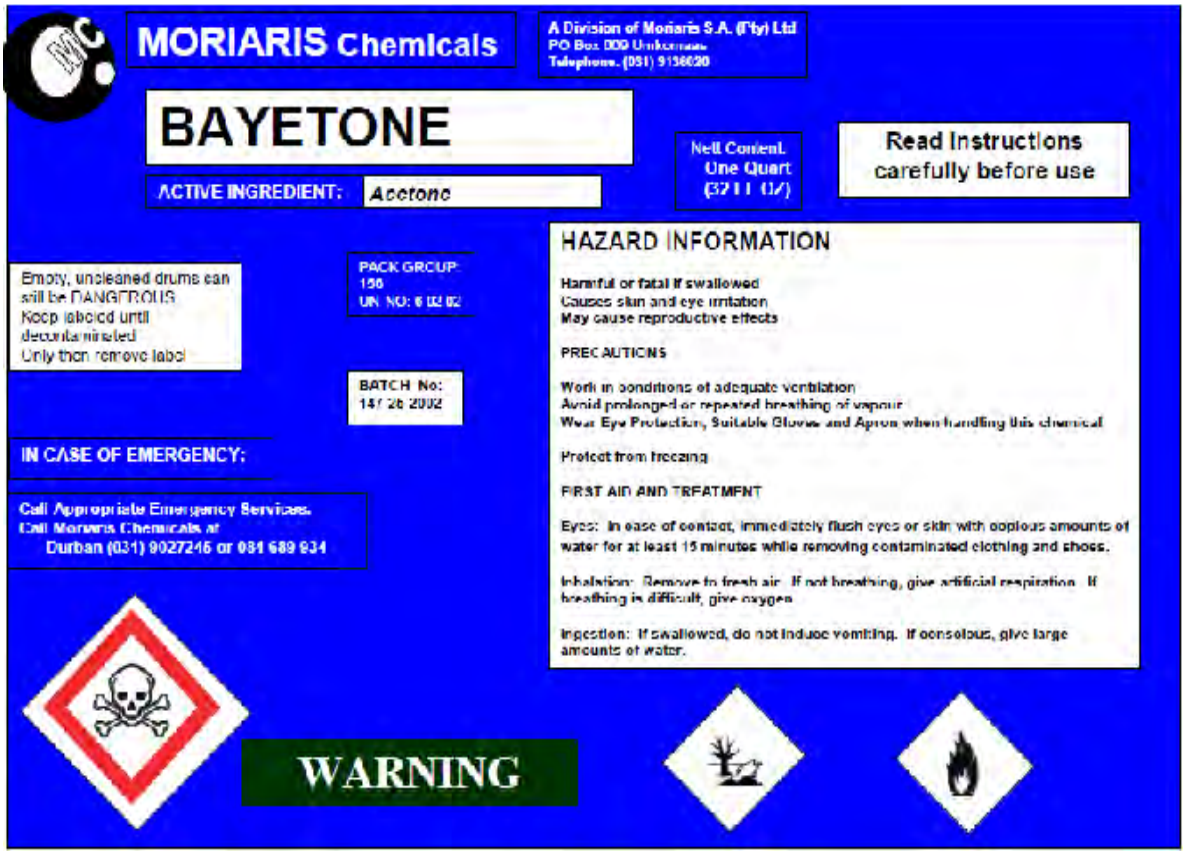
APPENDIX B: SALOC AND BAYETONE LABELS





APPENDIX C: CONSENT FORM

CONSENT: Consent for participating is sought individually with each participant.

- *Good morning/afternoon.*

- *My name is interviewers name _____. I work for the University of Cape Town*
- *Thank you for agreeing to speak to me. I would like you to help us with a safety project.*

- *I will be asking you some questions, as well as showing you some papers. Your answers will be very helpful for us to advise how workplaces and homes can be made safer.*

- *Even though we will be asking you a lot of questions,* ***this is not a test of your ability or knowledge. You will not be judged by how well or poorly you answer any questions.*** *We are testing the information we will be showing you and not your ability. All we ask is that you try to answer the questions as truthfully and as best as you can.*

- *There is no need to rush and you must not feel you have to impress us when you answer. Please remember that any information we collect will be kept anonymous and confidential. Nobody, other than the researchers (myself and my colleagues) will know how you answered any of the questions.*

- **READ TO WORKERS ONLY:**
- *Your participation will not affect your job and your supervisor/manager has agreed that you can participate. He/she knows that your answers will remain anonymous.*

- *It will take about 1 hour to conduct these interviews.*

- ***After you are finished we will give you an acknowledgement for your time spent with us and some safety information.***

- *Do you have any questions? We would be happy to answer them.*

- *Do you feel you understand why you are participating in this project? Are you happy to participate in this project?*

- *Thank you, we will now go ahead.* ***Remember****, even though you have said you are happy to participate, you do have the right to stop at any time if you so wish.*

Tick if respondent has verbally consented to participating in this study.	☐

APPENDIX D: ETHICS APPROVAL LETTER

UNIVERSITY OF CAPE TOWN
Faculty of Health Sciences
Human Research Ethics Committee

Room E52-24 Old Main Building
Groote Schuur Hospital
Observatory 7925
Telephone [021] 406 6492 • **Facsimile** [021] 406 6411
Email: Sumayah.ariefdien@uct.ac.za
Website: www.health.uct.ac.za/fhs/research/humanethics/forms

15 June 2015

HREC/REF: 279/2015

Prof A Dalvie
School of Public Health & Family Medicine
Environmental Health Division
Room 4.31
Falmouth Building-FHS

Dear Prof Dalvie

Project Title: DEMOGRAPHIC DETERMINANTS OF CHEMICAL SAFETY INFORMATION RECALL IN WORKERS AND CONSUMERS IN SOUTH AFRICA (Sub-study linked to 107/2004) Masters candidate Ms F Sathar

Thank you for your response letter dated 02 June 2015, addressing the issues raised by the Human Research Ethics Committee (HREC).

It is a pleasure to inform you that the HREC has **formally approved** the above mentioned study.

Approval is granted for one year until the 30 June 2016.

Please submit a progress form, using the standardised Annual Report Form, if the study continues beyond the approval period. Please submit a Standard Closure form if the study is completed within the approval period.

We acknowledge that the following student:-Farzana Sathar is also involved in this project.

Please note that the on-going ethical conduct of the study remains the responsibility of the principal investigator.

Please quote the HREC REF in all your correspondence.

Yours sincerely

PP TuBurgess

PROFESSOR M BLOCKMAN
CHAIRPERSON, HSF HUMAN ETHICS

Hrec/ref: 279/2015

Federal Wide Assurance Number: FWA00001637.
Institutional Review Board (IRB) number: IRB00001938

This serves to confirm that the University of Cape Town Research Ethics Committee complies to the Ethics Standards for Clinical Research with a new drug in patients, based on the Medical Research Council (MRC-SA), Food and Drug Administration (FDA-USA), International Convention on Harmonisation Good Clinical Practice (ICH GCP) and Declaration of Helsinki guidelines.

The Research Ethics Committee granting this approval is in compliance with the ICH Harmonised Tripartite Guidelines E6: Note for Guidance on Good Clinical Practice (CPMP/ICH/135/95) and FDA Code Federal Regulation Part 50, 56 and 312.

APPENDIX E: JOURNAL GUIDELINES FOR AUTHORS

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INTRODUCTION

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Science of the Total Environment is an international journal for publication of original research on the **total environment**, which includes the **atmosphere**, **hydrosphere**, **biosphere**, **lithosphere**, and **anthroposphere**.

totalenvironment.gif

The total environment is characterized where these five spheres overlap. Studies that focus on at least two or three of these will be given primary consideration. Papers reporting results from only one sphere will not be considered. Field studies are given priority over laboratory studies. The total environment is studied when data are collected and described from these five spheres. By definition total environment studies must be multidisciplinary.

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stoten-banners.jpg

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- Air pollution quality and human health
- Contaminant (bio)monitoring and assessment
- Ecosystem services and life cycle assessments
- Ecotoxicology and risk assessment
- Emerging fields including global change and contaminants
- Environmental management and policy
- Environmental remediation
- Environmental sources, processes and global cycling
- Groundwater hydrogeochemistry and modeling
- Human health risk assessment and management
- Nanomaterials in the environment
- Noise in the environment
- Persistent organic pollutants
- Plant science and toxicology
- Remote sensing
- Stress ecology in marine, freshwater and terrestrial ecosystems
- Trace metals and organics in biogeochemical cycles
- Waste and water treatment

The editors discourage submission of papers which describe results from routine surveys or monitoring programs, studies which are local in scope, laboratory experiments, hydroponic or pot studies

measuring biochemical/physiological endpoints, food science studies, screening of new plant species for phytoremediation, testing known chemicals in another setting, and experimental studies lacking a testable hypothesis.

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Reviews. Critical evaluation of existing data, defined topics or emerging fields of investigation, critical issues of public concern, sometimes including the historical development of topics. Those wishing to prepare a review should first consult the Editors or Associate Editors concerning acceptability of topic and length.
Discussion. Opinionated exposition on an important scientific issue or event designed to stimulate further discussion in a broader scientific forum.
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State the objectives of the work and provide an adequate background, avoiding a detailed literature survey or a summary of the results.

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A Theory section should extend, not repeat, the background to the article already dealt with in the Introduction and lay the foundation for further work. In contrast, a Calculation section represents a practical development from a theoretical basis.

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Results should be clear and concise.

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Conclusions

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