The role of pictograms in the conveying of consumer safety information

GOVERNMENT CONSUMER SAFETY RESEARCH

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Department of Trade and Industry

Contents page


Woolmark


Corrosive chemical symbol


Recycled symbol


Oxidising symbol

Toy warning pictogram


Kitemark

Introduction and Summary

This report summarises the results of a study funded by the Department of Trade and Industry's Competition and Consumer Affairs Policy (CACP) Directorate to assess the role of pictograms in conveying consumer safety information. In addition to describing the methods and results of the study, it summarises the policy position of the CACP on the current and future role of pictograms in consumer safety.

The study involved:

- a survey of pictograms currently in use in the UK
- a review of literature on the effectiveness of pictograms and warnings in general
- an experimental assessment of the comprehensibility and effectiveness of a selection of pictograms.

1 Findings and recommendations of the study

The following is a summary of the most important findings of the study, and the recommendations that have been made as a result.

Consumer information, warning design and the use of pictograms as a medium for consumer safety information continues to be much researched. At the same time the internationalisation of markets, in particular the European market, has meant that pictograms have been seized upon as an economical tool to illustrate safety related messages on consumer products, due to their potential to avoid explaining messages in a number of languages. There is concern over the proliferation of pictograms: that new pictograms may be developed that are not needed; new pictograms are developed that are not effective; and that an un-checked increase in the number of pictograms in use may decrease the effectiveness of those that are already established.

There are problems with the use of safety warnings in general; there is still discussion even on the methods used to assess the effectiveness of any type of safety warning. Warnings do not replace the need to educate consumers generally through other forms of safety publicity.

1.1 Advantages and drawbacks of pictograms

There are a number of recognised advantages of pictograms:

- Pictograms can make warnings more noticeable or “attention grabbing”.
- They can serve as “instant reminders” of a hazard or an established message.
- They may improve warning comprehension for those with visual or literacy difficulties.
- They have the potential to be interpreted more accurately and more quickly than words.
- They can sometimes be recognised and recalled far better than words.
- They can improve the legibility of a warning.[1]
- Pictograms or brief textual information may be better when undertaking familiar or routine tasks(although the opposite will apply for novel or highly complex tasks).

However there are a number of disadvantages of relying on pictograms:

- Very few pictograms are universally understood.
- Even well understood pictograms will not be interpreted correctly by all groups of consumers and across all cultures, and it always takes many years for any pictogram to reach maximum effectiveness.
- There is the potential for critical confusion (interpreting the opposite or often undesired meaning) which can create an additional safety hazard.
- Any advantages in noticeability will be affected by size, positioning and clutter on the packaging, issues which are not currently addressed by standards.

1 Pictograms can be read more easily at a distance compared to textual information although a distinction is made between abstract symbols and pictographs - described as more detailed and therefore likely to remain less legible (Jacobs, 1975).

- The majority of studies seem to suggest that while pictograms may have some role in safety information they are not a guaranteed solution to improving the effectiveness of text only messages.
- Safety pictograms must be used judiciously to preserve their effectiveness.

1.2 Effective use of pictograms

There are a number of guidelines to be followed when developing or applying a pictogram to consumer safety information:

- There are no strict rules on what makes a good pictogram. It depends on the product, the hazard, and the consumer audience, and must be fully consumer tested.
- There is evidence to suggest that it is more difficult to design pictograms to convey complex safetymessages. Care should be taken particularly with the use of pictograms to describe complex prescriptive or proscriptive messages.
- There may be two possible functions for pictograms: as a reminder/attention grabber for an established message, or to stand alone to convey a message. These different functions require different treatment.
- No pictogram will be instantly effective. The longer a pictogram is in circulation the better known it will be.
- Needless differences in the design of pictograms will work only to undermine their effectiveness.
- Consumer testing is of utmost importance in the development of any pictogram. Testing should be:
  - contextual (putting the pictogram in context with the product or environment in which it is to be used)
  - carried out using qualitative and quantitative techniques
  - based on a representative sample of consumers
  - performed across cultures if appropriate.
- Research has shown that visual material is readily learned and there may be advantages in selecting pictograms on the basis of how easily they can be learned rather than on how well they are comprehended when first seen. This however requires investment in consumer education.

1.3 Recommendations of the study

The following recommendations have been made as a result of this study.

1 Any future increase in the number of pictograms in consumer information must be checked if their advantages are not to be diluted.

2 Existing design conventions need to be identified and evaluated to guide any future development of pictograms - this would include design conventions that are considered successful and those to be avoided.

3 The development of new pictograms and any future adaptations or applications of existing pictograms needs to be controlled, preferably internationally. This should monitor and prioritise their use and establish a protocol for their future development.

4 A protocol for the introduction of new pictograms should account for all possible costs and benefits. Unless the benefits are greater than the costs or the same benefits can be achieved for a lower cost by using an alternative route e.g. generalised publicity, text-only warnings or product development, then the pictogram should not be taken forward until these other routes have been fully considered. A possible checklist for development would include:

- evaluate the real need for the pictogram - consider what other routes are open to reducing risk or conveying the safety message
- assess the time and cost of development and full consumer testing; evaluation must be cross-cultural, take account of all relevant factors such as size, positioning and clutter and use real-world contexts
- estimate the time needed for the pictogram to become established and reach its maximum potential value
- assess training requirements: some pictograms will require consumer education to reach their potential and the cost of adequate publicity and training may be more than that required by other routes
- identify any potential critical confusions with other pictograms or messages that could be implied by the current one
- carry out an appraisal of likely effectiveness and required change in behaviour
- identify future developments: is the hazard likely to be ‘designed out’?; what is the life expectancy of the product or hazard?
- evaluation of other routes for cutting down text in multiple languages such as targeting groups of countries

5 A prioritisation system for using pictograms needs to be established based on strict criteria. These include specifying a level of risk which necessitates the development of a new pictogram; physical restrictions (such as space) to rule out the possibility of alternative or supporting textual information.

2 Background

The term pictogram is a collective term used to describe both ‘symbols’ - considered to be abstract representations whose meaning must be learnt - and ‘pictorials’ - more representative pictures depicting messages (Mayer and Laux, 1989). For the purposes of this report a safety pictogram is a *diagrammatic representation using pictures rather than words to convey a hazard warning or safety message, but which can include text or alphanumeric information.*

A number of terms are used to describe what ostensibly could be considered a pictogram, depending on the industry and application in which it is used:

graphic -

any image used to convey a visual message, can include lines, shapes, shading and stylised letters

symbol -

a graphic combined with form, colour, shape and size to produce a symbol representing a specific referent whose meaning must be learnt

icon -

used within the computer and related industries to refer to a graphical representation of a function

logo -

a symbol used to represent a corporate name

mark -

a symbol used to represent a collective group such as trade associations

pictograph -

can be used interchangeably with pictogram

pictorial -

a representative image, often showing relationships such as movement or time

sign -

a combination of symbol and other graphic or text message

Pictograms are found on products, in or on product packaging, on safety instructions supplied with the product and in/on publicity material provided with the product. They are also used to display information on signs and on equipment. Pictograms can be used alone as hazard/safety warnings or alongside complementary measures. It appears that current trends may be to rely on pictogram usage to solve the problems of the internationalisation of markets and work forces to avoid the need to display information in several different languages on product packaging and signs.

3 Survey of pictograms currently in use

3.1 Classification of pictograms

A number of attempts have been made to provide classification guidelines for pictograms.

Dreyfuss (1972) collected and reviewed twenty thousand graphic symbols and developed three categories: representational, abstract and arbitrary.

Representational symbols -

Fairly accurate simple pictures of the object. They are the easiest symbols to comprehend as they are simplified pictorial representations of objects.

Abstract symbols -

Reduce the main elements of a message into graphic terms. The graphic representation of abstract symbols usually bears only a slight resemblance to the message which it portrays.

Arbitrary symbols -

Have been invented and therefore need to be learnt. The best examples of these are road traffic signs.

Easterby and Hakiel (1977) described the image content of a sign and the type of message being portrayed as one of the following three modes:

Descriptive -

The image identifies the hazard.

Prescriptive -

The image specifies some positive course of action to be taken in association with the hazard; for example, wear protective gloves.

Proscriptive -

prohibiting some course of action; for example, do not drink.

3.2 Standardised pictograms

A review of graphical language identified that there are no generic design guidelines or standards in place for safety pictograms placed on consumer products. Standards do exist for certain groups of pictograms and for a small number of individual consumer safety

pictograms. These are most notably road signs, safety at work signs, public information signs, chemical labelling and a small number of consumer-product pictograms which have been established and/or standardised for specific products or hazards. Notable amongst these is the new toy safety pictogram produced by the European Committee on Standardisation of Child-Care Products and introduced in all EU member states in 1995 after cross-European evaluation (BSEN 71-6/BS5665 part 6).

A summary of these standardised signs and pictograms is given in Appendix A.

3.3 Standards related to pictograms

Standards related to the design and use of pictograms in the UK, Europe, USA and elsewhere are listed in Appendix B. There are few standards governing the use of pictograms in the UK specifically for consumer product safety, the exception being the new toy safety pictogram and the labelling of dangerous substances.

4 Literature relating to warning effectiveness and the role of pictograms

4.1 Introduction

People encounter a variety of safety-related information as part of their everyday lives. Lehto (1992a) divided this information into four categories:

- safety markings (e.g. colouring emergency stops red or highlighting the edges of steps)
- safety signs and labels (which display textual and/or pictorial safety information)
- safety instructions and training
- safety propaganda (methods of persuading people to behave in particular ways).

It can therefore be seen that safety information may play a number of roles; warnings however, have a particular function, which has been described as: *"...to reduce the risk of personal or property damage by inducing certain patterns of behaviour and discouraging or prohibiting certain other patterns of behaviour"* (Dorris and Purswell, 1978 - in Lehto, 1992b, page 116).

A great deal of work has been published on warning design in general. This section reviews some of the issues associated with consumer safety information and, in particular the use of pictograms in warning signs and labelling.

4.2 Factors influencing the effectiveness of consumer safety warnings

The effectiveness of pictograms cannot be reviewed in isolation from the wider issues surrounding warning effectiveness in general.

It cannot be assumed that simply because a warning is provided, people will modify their behaviour accordingly (Ayres et al, 1989). Studies have shown that there are a number of factors which contribute towards the effectiveness of a warning message, namely: the users' perceptions of the risk associated with a product, user familiarity with it and how much effort is needed to carry out the required behaviour.

According to a number of authors including Trommelen (1994) and Vaubel and Young (1992), perceived hazard level breaks down into two principal sub-components: (i) the perceived severity of injury (ii) the perceived likelihood of injury. Various studies have suggested that one or the other of these factors is primary, but findings have not been consistent.

The issue of familiarity is important as it appears to influence how hazardous people are likely to perceive products to be. The most obvious trend in the research literature suggests that the more familiar someone is with a product the less likely they are to see it as hazardous (Wogalter et al (1986); Godfrey et al (1983) - although LaRue and Cohen (1987) have argued that this relationship is true for women but not for men).

As to how these factors affect willingness to read warnings, Wogalter et al (1986) found perceived hazard level to be the primary factor in whether or not a warning is likely to be read. Their study also found a significant negative correlation between familiarity with a product and the likelihood of reading a warning.

The literature in this area is highly complicated and, in many places, contradictory. Nevertheless, one reasonable, albeit speculative, conclusion is that perceived severity of injury is the primary factor in getting users to look for or at a warning, whilst perceived likelihood of injury appears to be more influential when it comes to effectiveness.

The cost (or effort) of complying with warnings has also been looked at in a number of studies (e.g. Wogalter et al, 1987b). Dingus et al (1991) found that including protective equipment in the packaging of consumer products substantially increased warning effectiveness. Not only was the effort of complying reduced (because the protective equipment necessary was immediately to hand) but the presence of protective equipment also increased subject's perceptions of the hazard level of the product (something which was not affected by the several different designs of warnings tested).

So is it worthwhile including a warning at all? According to the likes of Dejoy (1989) and Friedmann (1988) it is, although Dejoy points out that this view is based on fairly limited data (see, for example, Wogalter et al, 1987b and Otsubo,1988).

There is certainly a 'drop-off' effect for warnings. A number of studies have shown that of those who notice a warning, only some will read it, and even less will take the precautions recommended (Friedman, 1988 - see also Otsubo, 1988 and Strawbridge, 1986).

4.3 When should warnings be applied

McCarthy et al (1995) argue that warnings should be used judiciously with priority given to those that involve the most serious risks and where there is a reasonable chance of changing users' behaviour, and that warnings concerning unavoidable risks and obvious hazards should be omitted.

Lehto (1992b) has commented that the drive to provide warning labels is often provided by the legal profession and the concern to explicitly warn against all hazards. This is despite research which indicates that warnings applied in this way are likely to lose their effectiveness (Lehto and Miller, 1986). McCarthy et al related the number of warnings a person encounters to the effort of 'processing' this information, arguing that the likelihood of reading and complying with warnings will decrease as the effort rises. The authors comment, however, that no research presently exists to identify what is a reasonable number of warnings and, equally, when too many have been provided.

4.4 Research methods used to evaluate warnings

Warnings are aimed at modifying users' behaviour in some way. The concept of warning *effectiveness* should therefore be considered in terms of whether or not an appropriate change in behaviour is achieved. While effectiveness has proved difficult to measure, a variety of approaches have been developed (Dejoy, 1989):

- comprehension of pictograms - do people understand what a pictogram means?
- warning detection - do people notice warnings?
- reading time/rate - how fast can the warning be seen and/or understood?
- recall - do people remember seeing a warning or do they remember what a pictogram means?
- assessing how people perceive a product and whether or not they think a warning is needed
- behavioural compliance - does the warning bring about an appropriate change in behaviour?

The following is a review of some of these approaches to measuring the effects of pictograms in warnings.

4.4.1 Comprehension studies

Many studies have evaluated the comprehension of different warning designs. Approaches used have included pictogram recognition or matching (where responses are either 'open-ended' or matched from a list already provided), message recall, psychometric scales (where subjects either rate what they understand from a warning - such as the likelihood of injury - or a semantic differential approach is taken) and readability indexes.

4.4.1.1 Real world studies

Much of the work examining behavioural compliance has been laboratory based. In a review of research into the effectiveness of consumer product warnings, DeJoy (1989) commented that the majority of studies are based on research carried out in the laboratory using college students as subjects, and that work examining existing warnings through representative user populations is non-existent.

Lehto (1992a) states: "*there is a strong need to evaluate under realistic conditions the extent to which a warning sign or label influences behaviour, simply because human behaviour is difficult to predict.*" (page 108).

However, whilst surveying factors influencing the perception of warnings, LaRue and Cohen (1987) replicated a previous study by Wogalter et al (1986) which allowed them to investigate whether using a random sample of consumers would make any difference. In the event their study suggested that results using samples of undergraduates can be safely extrapolated to the wider consumer population.

4.4.1.2 Standardised assessment of comprehension

There are standardised procedures for evaluating the comprehension of pictograms (see Appendix B for details of standards).

The method of testing comprehension of pictograms used in ISO 9186 (Public Information Signs), relies on judges placing responses into the following categories:

- correct understanding of the symbol is certain
- correct understanding of the symbol is likely
- correct understanding of the symbol is marginally likely
- the meaning which is conveyed is the opposite to that intended
- the response is wrong
- the response given is don't know
- no response is given.

For a symbol/pictogram to be accepted, sixty-six percent of judgements must be in the first two categories and can also include the third category for less critical referents.

In the American standard ANSI Z535.3 (Safety Signs), four categories are used to judge safety symbols:

- correct
- wrong
- critical confusion (that is, the opposite of correct)
- no answer

The required level of correct answers set out in the standard is eight-five percent, however no guidance is provided as to the level of correctness an answer has to have to be judged correct.

4.4.2 The effect of pictograms on warning noticeability

Guidelines given for warning designs frequently suggest increasing the salience or conspicuity of warnings. Young (1991) examined four methods of increasing noticeability, which are frequently recommended: pictorial, colour, signal icon and border (although little research is available in the public domain to support this, it is presumed that a huge body of unpublished research exists within the advertising industry). The four salience variables were manipulated on alcohol labels. Warning recognition time was used as a measure of noticeability. The results showed that pictorials, colour and icons can all enhance the noticeability of warning information. However, the author notes that salience manipulations interact with each other and therefore they must be combined with care.

Young and Wogalter (1988) addressed the issue of whether making warnings more conspicuous will enhance memory of the warning. They argue that this is important in cases such as instruction manuals for hazardous products, when users may not have the manual to hand when using the product. They examined recall of warnings contained in the instruction manual of a generator. They found that when the warning was printed in conspicuous print (larger font and fluorescent orange highlighting) and accompanied by a "meaningfully-related" icon, recall of both the verbal warning content and the semantic meaning of the icons, was significantly improved.

The authors cite the work by Robinett and Hughes (1984) who argue that the complex nature of many hazards means that icons alone cannot communicate the necessary warning information. Instead, in many cases, icons need to be paired with written warning messages. In this way icons may not only act as "attention-getters" but may also act as cues, facilitating recall of an associated warning message.

4.4.3 The effect of pictograms on behavioural compliance

Jaynes and Boles (1990) examined the effects of warning pictograms on behavioural compliance, stating that most of the research into symbols has been into their effects on noticeability, comprehension and recall. Their study examined compliance with Personal Protective Equipment (PPE) warnings on an instruction sheet in a chemistry laboratory exercise. The study suggested that adding pictographs to a verbal warning will increase compliance rates. This finding is at odds with previous studies which did not show pictographs to have a significant effect on behavioural compliance.

In a behavioural study of warning labels on consumer products (a circular saw and a jigsaw), Otsubo (1988) found that the type of label (words only, pictograph only or words and pictograph) did not significantly affect whether subjects noticed, read, complied with, comprehended or remembered the warning. However the number of subjects complying with the warning labels (twelve and a half to fifty percent) in comparison to the control group where no-one took precautionary measures, supports the argument for well designed product warnings. The study also showed that products which varied in "hazard level" influenced the effectiveness of warnings. The highest level of compliance was found for the words plus pictograph warning on the product perceived as most dangerous.

4.5 The effectiveness of pictograms for different groups of consumers

In one of the largest UK investigations into safety labelling of consumer products, Easterby and Hakiel (1981) investigated differences in comprehension of pictograms according to age, sex, number of children and working status. A range of signs for five hazards (fire,

poison, caustic, electrical and general hazard) were tested for comprehension performance using a structured random sample of four thousand respondents.

The results suggested that, firstly, familiarity with the sign improved comprehension. Secondly, comprehension of signs was higher for males than females. Age was also found to affect sign comprehension, with the older age group (fifty-five years and over) performing poorly. Finally, looking at household composition, respondents having young children (under six years) in their household comprehended signs better than those without young children.

Based on the results of their study the authors defined young or middle aged people who are working and have young children at home as the group of people most likely to correctly comprehend a symbolically coded sign. Elderly people who are not working or do not have young children in their household, are least likely to comprehend pictograms.

Other studies have found that female students were more likely to look for warnings than their male counterparts (Godfrey at al, 1983). Also, females have been found to be more likely to feel that a product should have a warning and are more willing to read a warning, regardless of the perceived level of danger of the product. Perceived level of danger and familiarity with the product are important for male consumers. They tend to read warnings only when they perceive the product to be dangerous, unfamiliar or in need of a warning (LaRue and Cohen, 1987). Other ongoing work by the DTI on related areas such as safety labelling and instructions also supports these findings.

4.6 Comprehension of pictograms across different countries and cultures

Few studies have examined comprehension of pictograms across users from different countries.

Akerboom (1993) found differences in comprehension of pictogram elements (to indicate a choking hazard with toys with small parts) across the Netherlands, France, Italy, Sweden, Greece and the United Kingdom. The resultant pictogram (later to become the toy safety pictogram incorporated into BS EN 71-6: 1995 - see Appendix B) was correctly comprehended by seventy-seven percent or more of the respondent population in all countries except France and Greece. The author argued that the relatively low comprehension levels for these two countries meant that the pictogram should be supplemented by a written message or specialised training.

In Australia, Carney and Sless, (1979) investigated the comprehension of occupational safety symbols according to cultural background and literary levels: migrants of European origin, recent immigrants from Vietnam, and Australians attending adult literacy classes. The symbols were tested twice, once to examine initial recognition and then a week later to test recall (to identify how easily they are learned). The groups varied in how well they could

recognise particular symbols and how well they were learnt; for instance, some symbols were clearly misunderstood by the Vietnamese immigrant population compared with subjects with a European background. However a consistent pattern of results were found across all the ethnic groups for the relative effectiveness of the different signs.

4.7 Pictogram design

The following is a discussion of the components of pictogram design which are commonly used to improve comprehension:

- colour
- shape
- negation signs
- signal words
- explicitness
- order
- alternative forms

Research has shown that there is often contradiction and justification in the efficacy of these methods.

4.7.1 Colour coding

Colour coding is frequently put forward as a consistent way of signifying the level of hazard: red for the highest danger level, orange to identify a hazard, yellow for caution, green for first aid and blue for sources of safety information (Lehto 1992b).

However, it has been found that colour coding is not important for sign comprehension when the image is adequate, so long as minimum requirements for legibility and conspicuity are satisfied. Only where comprehension was poor, has colour been shown to influence performance (Easterby and Hakiel, 1981).

In a study of abstract road signs it was found that in most cases the shape of the sign alone was sufficient to communicate these abstract concepts - they did not require both shape and colour coding (Jones, 1978). However, it was acknowledged that the colour red has an important role to play through its association with danger, probably acting as a cue to alert drivers to warnings and orders. Colour is therefore recommended as a cue for signalling essential rather than optional messages. Shape can then be used to differentiate between specific types of messages.

Also, it has been shown that it is number of colours in total in a visual field, in addition to the number of different colours, that determines how effective colour is as a cue (Carter and Cahill, 1979).

4.7.2 Shape

There is research evidence to suggest that 'pointed' shapes (e.g. diamonds or triangles and other regular shapes with a downward pointing vertex) signify hazards more effectively than other shapes such as circles or rectangles (eg Lehto, 1992b; Jones, 1978; Cochran et al, 1981; Riley et al, 1982; Collins, 1983).

Also there is work to show that the triangle on its vertex is the preferred warning surround, a circular enclosure is one of the least preferred (Riley et al, 1982). Further investigations have found however that enclosure shape does not affect compliance rates, demonstrating the importance of undertaking behavioural studies rather than relying on preference data (Jaynes and Boles, 1990).

4.7.3 Negation signs

Research looking at differences in reaction time plus subjective assessment concluded that a thin black cross is more effective in conveying negation than a thin black slash, a partial slash or cross, and a contour slash or cross. No significant differences were found in the extent to which these different designs interfered with symbol recognition. Also, Dewar (1976) advocates the replacement of the "widely employed slash" by a partial slash (i.e. one which does not pass over the symbol). In his work on road traffic signs, Jones (1978) strongly supports the use of a slash in addition to the circle shape to convey messages of explicit prohibition.

4.7.4 Signal words

These are intended to signify the level of a hazard, thereby minimising the chance that the significance of the hazard will be misinterpreted. The words DANGER, WARNING and CAUTION have been suggested in order to signify decreasing levels of severity (e.g. FMC Corporation, 1985). According to Silver et al (1993) DANGER should be used to denote situations which involve *"immediate hazards that will result in severe personal injury and death"* whereas WARNING denotes *"hazards that could result in severe personal injury or death"* and CAUTION *"hazards which could result in minor personal injury or damage"*.

However it is extremely unwise to rely on consumers being able to understand the intended distinctions between these words. Despite proposing the above classification, Silver et al (1993) comment that findings from research into whether people are actually able to distinguish between different levels of hazard associated with different signal words have not always been consistent. Lehto (1992b) suggests that simpler ways of stating the degree of risk may include using a numerical scale or descriptions such as 'extreme-danger', 'serious danger' and 'moderate danger'.

4.7.5 Explicitness of safety signs

Laughery et al (1991) examined whether making warnings more explicit (in terms of specifying potential injuries) and more severe (in terms of the seriousness of such injuries) would increase consumers' intentions to act cautiously. The results showed that explicitness and severity were very strongly related - only explicit warnings could accurately communicate warnings about severe hazards. Explicit warnings increased both subject's perceptions of injury severity and intention to act cautiously with a product. The authors therefore recommend the use of explicit warnings and also cite work by Laughery and Stanush (1989) showing that such warnings also get across more information about how to use a product safely.

4.7.6 Order of presentation

In a study of protective equipment, Wogalter et al (1987b) found that the position of a warning with respect to operating instructions was an important factor in compliance. Basically, they found that if the warning appeared before the instructions then the likelihood of compliance was significantly increased. Also, Friedmann (1988) found the order in which safety information itself is presented is important; a number of subjects read only the first sentence of a warning and skipped the rest.

4.7.7 Alternative label designs

Alternative label designs have been examined in a number of studies. Kalsher et al (1994) examined the problem of the limited surface area on pharmaceutical labels. Some people have trouble reading the small print which may be used on such labels. The authors suggest that increasing the size of the label in order to allow larger print and to provide enough room for warning information including pictorials is likely to be advantageous. They examined tag and fold-out labels in comparison to a standard format and found that the alternative designs, in particular the tag label, were preferred. The inclusion of pictorials had a substantial effect - labels with pictorials were preferred in all cases to those without.

Experimental work

The study included experimental work to answer some of the questions raised in the literature. This was in two parts: the first part looked at comprehension levels of pictograms currently in use in the UK (Section 5, pages 16-22); the second part attempted to assess compliance with warnings and the effect of pictograms on compliance (Section 6, pages 22-26).

5 Assessment of the comprehension of thirteen pictograms currently in use

5.1 Aim

The literature review highlighted the fact that there has been no study providing baseline data on UK levels of comprehension of standardised and non-standardised product safety pictograms. Despite the proliferation of both standardised and non-standardised pictograms, it is not known how well understood the pictograms are that are already in use. Newer pictograms on the marketplace are often tested for comprehension, but many established pictograms have never been through the testing process.

5.2 Method

Thirteen standardised pictograms related to consumer products were chosen for assessment. Three hundred and twenty five subjects were interviewed by a market research company in four UK cities, representative of the UK population by age and sex.

The pictograms were shown to respondents alongside photographs of the type of products on which they would be placed to put them in context. A staged questionnaire was developed (a copy of which is available from the authors). Open-ended questions aimed to build up a complete picture of the subjects' comprehension of the pictogram:

- the meaning of the pictograms
- the nature of the hazard
- the actions required to be taken to comply with the safety messages.

The pictograms were shown in random order (thirteen sets) with the exception of the two most similar pictograms, the oxidising pictogram and flammable pictogram, which were consistently kept ten places apart from each other.

The pictograms assessed are shown in figure 1 and were as follows:

Woolmark -

the internationally recognised certification mark of the International Wool Secretariat. Shown on products made from pure new wool.

Oxidising pictogram -

for use on products classified as an oxidising hazard and listed in the Packaging and Labelling of Dangerous Substances Regulations 1984.

Flammable -

for use on products classified as a flammable hazard and listed in the Packaging and Labelling of Dangerous Substances Regulations 1984.

St. Andrews Cross -

for use on products classified as harmful or irritant and listed in the Packaging and Labelling of Dangerous Substances Regulations 1984.

Corrosive chemical pictogram -

for use on products classified as a corrosive hazard and listed in the Packaging and Labelling of Dangerous Substances Regulations 1984.

Toy safety pictogram -

standardised in BS 5665 part 6 and currently used on products alongside a text warning.

Kitemark -

one of the British Standards Institute (BSI) certification trade marks, used on products made by manufacturers who consistently make them to the requirements of the appropriate British Standard.

Double insulation of electrical appliances -

found on a particular class of electrical goods which are built without any provision for earthing but with double insulation.

This product can be tumble dried -

standardised in BS EN 23758 and ISO 3758 (1991) Textiles - Care labelling code using symbols.

Recyclable pictogram -

the standardised “mobius loop” pictogram (ISO/TC 207/SC3/WG2/N98) to show that the packaging of the product can be recycled.

General hazard warning -

used alongside text to highlight warnings on products. Also recognisable as a international road sign used with text to warn of specific hazards.

Flammability of furniture -

the label to show that furniture has passed the tests outlined in BS 5852: fire tests for furniture.

'On' switch for electrical equipment -

as standardised in BS 7324: 1990; ISO 7000:1989.

5.3 Analysis

The questionnaire used open-ended questions and so a method of judging the 'correctness' of each answer was needed. Two judges with a background in ergonomics and safety issues were chosen to 'mark' each of the responses from the three hundred and twenty-five respondents. Using the 'correct' answer to each of the questions as a benchmark, they scored each response into a category from zero to ten (not necessarily into ten separate categories), with zero being a completely incorrect and ten a completely correct response. The judges worked independently of each other and a third judge was used to score responses on questions where there were discrepancies between the original judges' scoring. The comprehension of each pictogram was assessed in a number of ways:

1 the percentage of responses judged to be completely correct i.e. ten out of ten
2 the percentage of responses judged to be completely incorrect i.e. zero out of ten
3 the percentage of responses judged to be completely 'wrong' (completely incorrect plus no response and don't know)
4 a mean of the scores marked out of ten for each question (exclusive of 'don't know' and 'no answer')
5 any differences in scores between gender, geographical area and age
6 an analysis of the answer to the other questions surrounding each pictogram. This provided data on whether the required action with a safety message is understood despite the hazard or the pictogram itself not being completely understood

5.4 Results

Pictograms were ranked in order according to the three most important categories of comprehension: completely correct, completely 'wrong' and a mean score. An overall placement score was taken from these ranking scores. These are shown in table 1 (full results including the responses to all questions are shown in table 2).

Table 1 Ranked order of pictograms

Pictogram	overall placement	% correct	% "wrong"	mean correctness score
Woolmark	1	91	9	9.8
Flammable	2	85	5	9.4
Toy Safety	3	76	12	8.5
General hazard	4	52	10	8.9
Kitemark	5	54	18	8.9
Corrosive	6	29	9	6.3
Recycling	7	59	33	8.7
Furniture flammability	8	4	15	7.4
St Andrews Cross	9	24	27	5.7
Tumble dry	10	16	75	3.7
Oxidising chemical	11	2	41	2.3
'On' switch	12	6	88	3.7
Double insulation	13	4	85	3.5

5.4.1 Pictogram comprehension

Table 1 shows the pictograms ranked in order for overall comprehension levels. The ranking order has been produced by amalgamating the three types of scores. Mean comprehension scores are the mean score out of ten for the whole sample. This gives a good representation of the distribution of marks across the sample for each pictogram, although it must be remembered that they are exclusive of the “don’t know” and “no answer” data.

‘Correct’ comprehension was considered to be those responses given a ten out of ten score by the judges. Despite differences in their definitions of ‘correct’, the ISO eighty-five percent and ANSI sixty-six percent “correctness” values were used as a rough guideline against which to compare our results for comprehension of pictograms. Only the flammable and the woolmark pictograms were interpreted correctly by greater than 85% of the sample. The recently introduced toy safety pictogram was also well understood with 76% correct. The kitemark, the recycling pictogram and the general hazard pictogram were all correctly understood by more than 50% of the population; 54%, 59% and 52% respectively. However, the remaining seven pictograms were very poorly understood with less than 29% completely correct answers.

The ‘wrong’ answers are an important method of assessing comprehension. This consists of those responses judged completely incorrect (zero out of ten) plus the “don’t know” and blank answers (see table 2). The most notable results in this group were for the on pictogram, the double insulation of electrical appliances and the tumble dry pictogram, for which 88%, 85% and 75% of respondents were “wrong”. Other significant “wrong” results were the oxidising chemical pictogram at 41% and the recyclable pictogram at 33%. All other pictograms were judged wrong by less than 28% of the sample. It should be noted that the most poorly comprehended pictograms were abstract in nature e.g. the tumble dry and on switch.

5.4.2 Understanding of required action

Respondents were also asked about the nature of the hazard and what actions they should take if they saw the pictograms on the products. In general the correctness of the responses to these questions mirrored the responses to the first question about the pictogram meaning. Of interest was the interpretation of the toy safety pictogram. Although the pictogram itself was well understood (76% of the sample gave the correct meaning of the pictogram), only 27% correctly answered that the risk was choking.

5.4.3 Other findings

Statistical analysis showed that there was no significant difference between subject groups of social class, gender, age, region on any of the pictograms and the effects of having children on the comprehension of the toy safety pictogram.

Table 2 Full results of the assessment of comprehension of the thirteen pictograms

Pictogram	Question	Mean/10	10/10	1-9/10	1-10/10	0/10	D know	No ans	Wrong
Woolmark	1	9.8	91%	0%	91%	2%	6%	1%	9%
Oxidising	1	2.3	2	57	59	34	6	1	41
	2	2.7	4	61	65	27	5	3	35
	3	1.1	4	40	41	52	5	2	59
Flammable	1	9.4	85	10	95	3	2	0	5
	2	8.4	64	30	94	3	3	0	6
St. Andrews cross	1	5.7	24	49	73	10	17	0	27
	2	6.3	37	36	73	16	9	2	27
	3	5.3	18	65	83	5	10	2	17
Corrosive chemical	1	6.3	29	62	91	4	5	0	9
	2	6.6	39	53	92	4	3	1	8
Toy safety	1	8.5	76	12	88	7	5	0	12
	2	8.6	63	25	88	4	6	2	12
	3	7.9	27	62	89	4	5	2	11
Kitemark	1	8.9	54	28	82	3	15	0	18
	2	8.7	61	24	85	4	9	2	15
Double insulation	1	3.5	4	11	15	9	76	0	85
	2	2.3	3	6	9	15	66	10	91
Tumble dry	1	3.7	16	9	25	29	46	0	75
Recyclable	1	8.7	59	8	67	6	27	0	33
General hazard	1	8.2	52	38	90	4	6	0	10
	2	4.6	15	69	84	10	4	2	16
Flammability of Furniture	1	7.4	4	81	85	13	2	0	15
	2	5.3	2	72	74	24	2	0	26
On Pictogram	1	3.7	6	6	12	14	74	0	88

5.4.4 Discussion

Three of the five least understood pictograms were abstract (the tumble dry, on switch and double insulation pictograms). The poor performance of these pictograms could be due to the fact that their intrinsic design does not give any clue as to the message which they portray, therefore subjects are less likely to be able to make an educated guess as to the meaning of the message. In general most abstract pictograms need to be learnt. One of the other poorly comprehended pictograms was an ambiguous pictogram (oxidising chemical) which could easily have been confused with the pictogram for flammable products.

One of the newest pictograms in the study, the toy safety pictogram, performed relatively well, ranked third and with a comprehension level of 76%. This pictogram was developed in cross-European tests and its introduction was supported by public information.

The method used to judge the responses aimed to score the level of a subject's understanding of each pictogram rather than to provide a strict cut off point between a 'right' and 'wrong'. This method produced three sets of comprehension data and resulted in a considered ranking scale. The method of judging/scoring used differs from that which ISO (ISO 9186, 1989 - Public Information Signs) and ANSI (ANSI Z535.3 1991 - Safety Signs). The ISO scoring system categorises responses into level of correctness and looks at critical confusions, whereas the ANSI system is more limited in that symbols are either right, wrong or critical confusions, with no guidance on what constitutes right or wrong. The methods for assessing pictogram comprehension currently used in these standards may need to be addressed to bring about some conformity.

6 Investigation into the effect of pictograms on warning compliance

6.1 Aim

The second part of the experimental work looked at the issue of compliance with safety messages shown via pictograms. Studying compliance requires real world studies or laboratory experimentation where the subjects are unaware that it is their response to a warning that is being studied. There can be many problems encountered in the design of either of these type of studies. Difficulties can vary between the ethical problems of exposing subjects to the risks of the products being studied and designing an experiment to isolate the effects of warnings.

Because of these problems this study investigated *intended* compliance with a safety message. This safety message being the warning of small parts in a toy making it unsuitable for children under three years old.

The effects of different types of warning designs on intended compliance were studied, producing data also on noticeability of the different warning styles. The warning styles investigated were:

- text only
- pictogram only
- pictogram plus text
- general hazard warning plus text
- no warning

6.2 Method

The pictogram chosen was the new toy safety pictogram (see figure 1 and Appendix A)

Two toys were assessed, both containing small parts and therefore unsuitable for children under three years. One was a popular brand of building bricks (toy A); the second contained small plastic animals to encourage imaginative play (toy B). Both toys carried warnings stating they contained small parts. On the toy A this was shown via the new toy safety pictogram plus text in several languages and was located on the base of the box; on toy B this was a text warning only on the reverse of the packaging.

By use of colour scanning and multi-media techniques, the warning site of the packaging was manipulated to show the different warning conditions described above. All graphic information pertaining to developmental age suitability was also removed from the packaging.

Seventy parents were used as subjects (fifty-eight females and twelve males). They were contacted via a private day nursery, voluntary parent/toddler groups and local authority play groups from around Nottingham, to provide a mix of socio-economic groups. A group of twenty five male student non-parent subjects were used as a control group.

A between subjects design was used; subjects were shown both toys with the same warning design. The order of presentation of the toys was randomised within subjects.

Subjects were asked to study the toys in turn and to consider if the toys were suitable for a child aged two and a half. Subjects were given a choice of four responses: suitable, unsuitable, reservations about the toy's suitability and don't know. They were then asked to explain each toy's suitability. Subjects were asked if they had noticed any information on the packaging about the suitability of the toy. If not, they were asked to look for it. If it was not found, it was pointed out. (A copy of the questionnaire used is available from the authors).

6.3 Results

The results were analysed with respect to three main issues of pictogram effectiveness: noticeability, the perceived hazard level of the product and intended compliance with the warning (perceived suitability of the product).

Chi-squared tests were carried out between all variables to indicate significant results. Order effects were observed by comparing the group receiving toy A first against the group receiving toy B first. The control group was also compared for the effect of having children on the perceived hazard of the product. Chi-squared tests were carried out between all variables to indicate significant results. The main findings from the research were:

1 Subjects made their decision about whether the toy was suitable or not by judging its contents rather than seeking and or noticing the warnings. Out of a total of 152 decisions of whether the toy was suitable and a warning was present, the subjects noticed the warning *before* making a decision on only two occasions. On twenty-five occasions subjects had not noticed a warning and even after being told there was one on the packaging could not find it and it had to be pointed out.

2 The toys with no warning condition were not considered significantly any more or less suitable than those with any of the other conditions of warning message.

3 All subjects, that is parents as well as the control group of male students, were very aware of the hazards associated with allowing a small child to play with toys containing small parts. This appeared to be the main factor in deciding suitability of the toys rather than being aware of any warning. Out of a total of one hundred and ninety presentations of the toys, small parts was given as the reason for the toys being unsuitable on one hundred and forty-nine occasions.

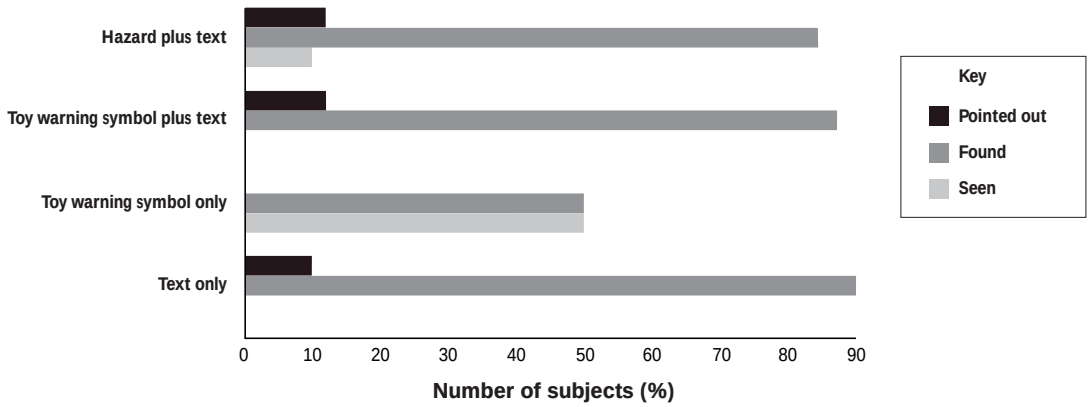
4 Statistically there was no difference between the control group and the parents scores on the noticeability of warnings, suitability of the toys or whether or not they mentioned small parts as the hazard χ^2 obs = 2.8, 3.2 and 3.3 respectively, where χ^2 crit = 6.0; therefore not significant at the 5% level).

5 There was a difference between the individual toys tested. Toy B was considered as being generally less suitable than toy A with a significant 24% of all respondents considering that toy A was suitable and only 5% of respondents considering the same of toy B. χ^2 obs = 18.1, χ^2 crit = 7.8; therefore significant at the 5% level) There were no significant differences between the results obtained from toy A and toy B with respect to noticeability of warnings χ^2 obs = 4, χ^2 crit = 6.0) or for hazard awareness χ^2 obs = 3.5, χ^2 crit = 7.8)

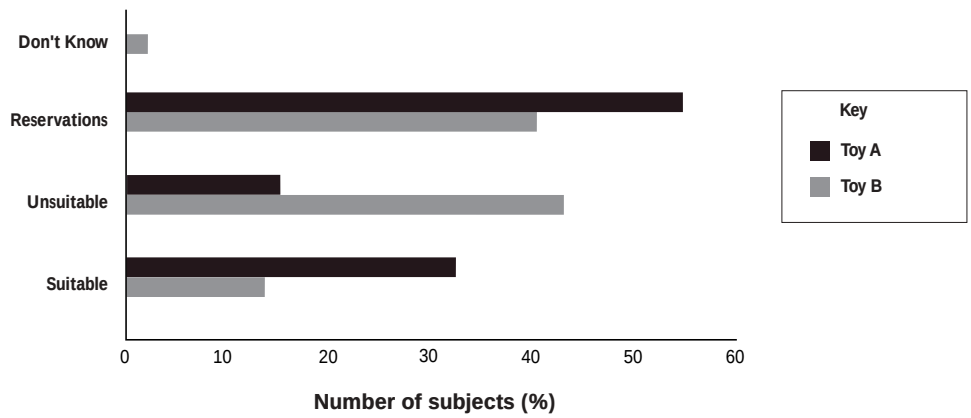
6 The issue of noticeability was investigated by first examining the entire data set (Kruskal-Wallis test) and then looking for differences between the warning conditions by carrying individual paired comparisons (Mann-Whitney non-parametric test). The results showed that toy safety pictogram on its own was the least noticeable warning condition with significant results when compared with the text only condition ($U = 238$; $p < 0.005$), the toy safety pictogram plus text ($U = 238$; $p < 0.005$) and the general hazard pictogram plus text ($U = 197$; $p < 0.001$). The general hazard pictogram plus text was the warning condition most noticed by respondents.

These results are shown graphically in the charts below.

Noticeability of different warning signs



Toy A versus Toy B Suitability



6.4 Discussion

The results of this part of the experimental work do not allow definitive conclusions to be drawn on the most effective design of warning. Most subjects made their decision over how suitable the toys were without observing the safety messages and most subjects were aware of the safety issues surrounding small parts in toys without receiving prompts from the warning. This suggests that a prior knowledge of a product and its associated hazards dictates behaviour with that product, more than any safety message, regardless of its design. This is supported by the statistical evidence that showed that the toys carrying the no warning condition were considered no more or less suitable than those carrying the other type of warnings.

One of the main findings from the research was the problems with noticeability of the toy safety pictogram when it was shown alone on the product. Fifty per cent of subjects were still unable to find the warning after having been asked to look for it on the packaging. There are several reasons for this problem of noticeability. One is the size of the pictogram on the products and the other the placement of the safety message. The toy safety pictogram was one centimetre diameter and placed on the base of the packaging of toy A and the reverse of toy B. Although the accompanying text in several languages expanded the total size of the warning considerably, the use of pictogram alone (as is the ultimate function of the newly designed cross-European warnings) made it very poorly noticed, particularly at this size.

The general hazard warning plus text performed the most effectively of any of the warnings. This could be due to the fact that it is a very well recognised warning trigger and draws the user to the text. The results certainly support the suggestion that pictograms are more noticeable when used with text and similarly that pictograms increase the noticeability of a text message. Further work from this could look at the noticeability of different size pictograms in comparison with text warnings. It may be found that it is the surface area of the warning on the packaging that makes a difference rather than the design of warning itself. The placement of the warning may also be important. The warnings were shown on the base or rear of the packaging and very few of the subjects turned the boxes until asked to do so.

7 Summary and discussion

7.1 Current use of pictograms

Consumers are bombarded by huge amounts of information in pictorial form. Pictorials are used in a wide variety of situations; they are used as marketing tools on products, to illustrate instructions, in signs, advertising and to display warnings on the roadside and public places. Many of these pictorials have been in use before national and certainly international standards existed, and many were developed originally without any consumer testing. Complicating the lack of standardisation, the advertising and marketing industries have sometimes been seen to adopt and adapt established pictograms, either negating or 'hijacking' their original meaning (e.g. the 'Ghostbusters' logo).

The majority of signs for road use, safety at work and public information type functions have been standardised internationally. In the two former cases, formal education is undertaken to ensure the comprehension of pictorials and signs. In the case of public information pictograms the signs rarely stand alone as information providers, with the addition of text and information desks as common alternatives.

There has been some standardisation of pictograms for use on consumer product labelling, but to a far lesser extent. Areas where pictograms are standardised include the labelling of dangerous substances, the care of textiles and graphical symbols on equipment, and recently the introduction of a new toy safety pictogram. This study has identified a wide range of standardised and non-standardised pictograms used on consumer products, such as marks for industrial standards, collective trademarks, product and company identification trademarks, and marketing and promotional pictorials. For the majority of these other pictorials there is no standardisation beyond at most what the specific industry bodies can do to regulate products within their remit. A large majority of consumer products have very cluttered packaging, which must have a bearing on the users' ability to pick out specific information, including that related to safety. The effectiveness of safety-related pictograms is questionable when they are immersed within the huge amounts of other pictorial or written information that is found on products.

A trend in safety pictograms appears to be, for example in the case of child-care products, the depiction of ever more complex messages. Pictorials recently developed for agricultural products are concerned with very specific prescriptive messages which are difficult to represent intuitively in a pictorial. The toy safety pictogram and the development of other child-care safety pictograms also has the complication of being cross-European work and therefore requires the comprehension of pictograms across a range of different cultures. These have highlighted the difficulties in producing pictograms comprehensible across all the European member states. This also raises the issue of training. The toy safety pictogram was supported in the UK with training literature. Pictograms that are supported with training have been shown to be an effective medium, even if initial comprehension is less than adequate, although this raises the issue of who should be responsible for provision of the training.

7.2 Review of literature

The review of literature on the effectiveness of pictograms has focused specifically upon the use of pictograms within a general discussion of warnings in consumer safety. Research has looked at the way pictograms are constructed, understood and at ways of measuring their effectiveness. Overall the research on pictograms is characterised by a great deal of contradiction and qualification.

There is a lack of real-world studies investigating the effectiveness of pictograms, due to the inherently difficult and ethically questionable nature of performing such work. Due to these inherent problems no definitive study has been performed and the majority of work carried out has been compromised. There is however consensus that any assessment of warning effectiveness cannot be carried out independent of either other design factors (type of packaging, size and position of warning) or of real world factors.

7.3 Experimental work

The survey of the comprehension of pictograms amongst the UK public showed that levels of comprehension for six out of the thirteen pictograms tested were less than 50%. Current Standards (ISO and ANSI) for new pictograms set criteria of 85% and 66% comprehension respectively, although the definition of 'correct' understanding differs between the two standards. Using the ISO criteria, only two of the pictograms assessed in this study would be acceptable, the flammable and the woolmark pictograms, the only pictograms correctly interpreted by greater than 85% of the sample.

Many of the pictograms assessed were unlikely to have been tested for comprehension prior to their introduction. The toy safety pictogram, which has been recently introduced across Europe and which was tested thoroughly as part of its development, was found to have a comprehension level of 72% and performed better than ten of the other pictograms tested. Three of the five least understood pictograms in this study were abstract pictograms, the meaning of which usually have to be learnt.

The effectiveness of any warning is ultimately judged to be a change in behaviour, which can be considered as users' compliance with a message. The experimental work in this study investigated the effect of warning style and pictograms on intended compliance, whilst also producing data on noticeability. The message to be complied with was the suitability of a toy for children under three years.

Ultimate compliance with any warning has proved very difficult to study, however the majority of the available literature seems to suggest that while pictograms do have some role to play they are unlikely to be the answer to radically improving compliance compared to a text-only message. Much of the intended compliance with pictogram warnings is more

likely due to the fact that users are particularly aware of safety issues surrounding a particular product rather than due to their reaction to the warnings themselves. In this study, product perceptions were shown to override any of the warning messages, regardless of design, such that intended compliance was no different with a product with no warning compared to those with a warning.

The literature had suggested that pictograms may be used to make warnings more noticeable.This was confirmed by our work; the general hazard warning plus a text message was significantly the most noticeable warning and the toy safety pictogram on its own was significantly the least noticeable. However the issue of noticeability is not only concerned with the style of the warning, but also its size, positioning and the amount of clutter on the packaging. Size and positioning are rarely specified in the warnings that have been standardised despite their obvious effects on noticeability. Clutter is another issue that is often overlooked. There appears to be a trend towards increased information on packaging, secondary to both legislation (e.g. the food labelling regulations) and also from the increase in marketing information placed on products. One can speculate that pictograms as warning messages can become lost amongst the other graphical information placed on the product. Studies have shown that use of borders around warnings can improve noticeability and help to deal with the issue of clutter.

Linking the work on noticeability with our findings on comprehension, we can conclude that there are difficulties in relying on pictograms alone unless they are experimentally shown to be both understandable and noticeable.

8 Conclusions

Pictograms have been identified as a economical medium for use to illustrate safety related messages on consumer products. With the internationalisation of markets, in particular the European market, tools that can cross the language barrier attract great interest due to their potential to remove the need to explain every message in every language.

The results of this study have shown that the issues surrounding the use of pictograms as consumer safety warnings are very complex. It had been hoped that this project would provide a checklist as to when, how and where pictograms should be used. The literature has highlighted the fact that there is a great deal of contradiction and qualification surrounding the issues in this area, although some clarity has been added by the results of this study.

This section of conclusions therefore aims to combine the results of the present study with areas of the literature where there is agreement on the role of pictograms in consumer safety.

8.1 General Conclusions

- There are problems with the use of safety warnings in general. Compliance with any message is heavily dependant on the consumer's perception of the hazards associated with the product.
- General education of the consumer as to the specific hazards of products is an alternative way to achieve behavioural change, particularly where the 'cost' of complying with a safety message is low.
- Pictograms are not the language free answer to written safety warnings. There is no clear objective evidence to suggest that they have any significant effect on ultimate compliance with safety warnings on products. Therefore the desire to decrease text information on packaging due to the internationalisation of markets must not take the route of language free pictorial warnings unless they have been proven to be effective across all the relevant cultures.
- Pictograms do however have a beneficial role as attractors to safety messages and as reminders of already established safety messages.
- The effectiveness of pictograms relies upon how well understood the message is. Our survey of the UK comprehension levels of thirteen pictograms shows that many of the pictograms currently in use are not well understood.
- The effectiveness of pictograms also relies upon their noticeability. This includes their size, their positioning on packaging and the amount of graphic clutter on the packaging. These are areas that therefore need to be addressed by the standards and legislation when specifying the use of pictograms as safety messages.

8.2 Pictogram design

- Very few pictograms are universally understood.
- There are differences in comprehension across different groups of consumers and different cultures.
- There are different 'languages' of pictorial information that exist e.g. road signs and safety at work signs. These are often used or 'hi-jacked' by other industries in an inappropriate manner.
- Abstract pictograms need to be learnt, have little or no intuitive comprehension and are therefore not well suited for the pictorial content of warning messages.
- Care should be taken with the use of pictograms to describe complex messages, particularly complex prescriptive or proscriptive messages. Stringent consumer testing can identify whether or not a particular message can be effectively conveyed by a pictogram.

8.3 Consumer testing

- Consumer testing is of utmost importance in the design of any useable interface. When designing pictograms as language free warnings testing is vital to ensure that the finished result is a message which is understood by a vast majority of the population and that critical confusions are kept to a minimum. Consumer testing as a part of an iterative design process can help to ensure good comprehension of pictograms and highlight safety messages which are maybe not suitable to be described in the form of a pictogram, whether this be with or without text. Effective testing therefore needs to be a integral part of the design process of each new pictogram; it should be contextual (putting the pictogram in context with the product or environment in which it is to be used), based on a representative sample of consumers and should be performed across cultures if appropriate.
- Due to the problems of noticeability, testing would also prove more effective if carried out in-situ on products, to provide information on the most effective placement of the pictogram and to account for issues of size and borders, the latter a requirement on cluttered packaging.
- There is contradiction between the international standards that exist for testing pictograms, both in the methods they use and the criteria for acceptance. There needs to be a review of these methods to produce some international conformity.

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The following is a review of design conventions and standards that exist for pictograms, signs and symbols with a relevance to consumer safety.

Appendix A Standardised pictograms, signs and symbols

The following is a review of design conventions and standards that exist for pictograms, signs and symbols with a relevance to consumer safety.

1 Road traffic signs

Road signs are standardised across Europe and as part of the driving test in most countries knowledge of the signs used on the road is tested as part of the process of gaining a full driving licence. The signs in use on the road are described in the UK by the Highway Code and are regulated by the Traffic Signs Regulations and General Directions 1981 produced by the Dept of Transport. The design themes used for road traffic signs, particularly the use of colour and shape, ensure quick recognition of different groups of signs. These design conventions have been used as the basis for the design of other warning symbols e.g. new toy safety pictogram and the poison symbol. Subtle changes are also made to these themes such as the use of negation crosses or slashes rather than relying on shape only as a suggestion of prohibition or warning. The design conventions are outlined below:

Warning signs -

white triangle with a red border and black graphic, usually a pictogram of the hazard e.g. left hand bend.

Regulatory sign - (mandatory)

circular or rectangular, usually with a blue background with white writing and graphic e.g. mini- roundabout sign.

Regulatory sign - (prohibitory)

white circle with a red border and black graphic (graphics are usually either descriptive or prescriptive in nature) e.g. no left turn.

Abstract signs -

abstract images that need to be learnt e.g. no entry and stop signs.

2 Safety signs at work

Safety signs used in the workplace are regulated by BS 5378 and ISO 3860 which specify a system of safety colours and safety signs related to accident prevention, health hazards and emergencies. The system relies heavily on pictograms as it has been developed with the minimum use of words due to the increase in international work and trade and the development of work forces which do not share a common language.

Prohibition Signs

Geometric shape:

Red circular band and a crossbar, the cross bar at 45 (descending diagonally from the left to right, thickness of band and cross bar 0.1 of the diameter of the sign.

Background: Colour white.

Symbol: Colour black, placed centrally on the background so that it does not obliterate the cross bar.

Text: Any text is placed on a supplementary sign.

Examples of use: Stop signs, Identification and colour of emergency, Shutdown devices, Prohibition sign.

Warning Signs

Geometric shape: A black equilateral triangle band, thickness of band 0.06 of the length of the triangle.

Background: Colour yellow, covering at least 50% of the area of the safety sign.

Symbol or text: Colour black, placed centrally on the foreground.

Examples of use: Identification of hazards (fire explosion, radiation, chemical etc.)

Warning signs: Identification of thresholds, dangerous passages, obstacles.

Mandatory Signs

Geometric shape: A circle

Background: Colour blue covering at least 50% of the area of the safety sign

Symbol or text: Colour white, placed centrally on the background

Examples of use: Obligation to wear personal safety equipment

Safe Condition Signs

Geometric shape: A square or oblong

Background: Colour green covering at lest 50% of the safety sign

Symbol or text: Colour white

Examples of use: First aid station signs

Fire Equipment Signs

Geometric shape: Square or oblong

Background: Colour red covering at least 50% of the area of the safety sign

Symbol or text: Colour white

Examples of use: Sign indicating presence of fire extinguisher

Supplementary Signs

Geometric shape: Square or oblong

Background: Colour white with text in black, or the safety colour used on the safety sign it is supplementing, with the text in the relevant contrasting colour.

3 Chemical product labelling

A system of product labelling is specified for use with product formulations outlined in the Packaging And Labelling Of Dangerous Substances Regulations 1984.

Toxic products -

the skull and cross bones pictogram warns of a danger of severe danger or death and for the user to avoid inhaling, swallowing or skin contact with the product. Used on all pesticides, anti-freeze, leather softeners, methanol, wood preservatives, paint strippers, ammonia, some thinners and clothing and fabric iron mould removers.

Harmful or irritant products -

the St Andrews cross, an abstract sign used on hazardous or irritant products warning of damage to or inflammation of the skin, eyes, nose and mucous membranes. This symbol is always accompanied by text providing an explanation of the type of hazard involved. Found on: stain removers, white spirit, paint strippers, some wood preservatives, some paints and glues and lathering cleaning products.

Corrosive products -

symbol showing liquid dripping from a test-tube onto a surface on one side and onto a hand on the other depicting the corrosive dangers of products where they can burn away flesh and mucous membranes, cause external or internal burns and eat into materials such as fabrics, wood or metal. Found on: drain and oven cleaners, acid for car batteries, de-scalers, caustic paint strippers, toilet cleaning products and dishwasher or washing machine powders or liquids when absorbed or wet.

Oxidising products -

warning of an increased risk of fire or that the product may spontaneously combust or react with other combustible products to cause fire. Found on: some hypochlorite-based weed-killer, hydrogen peroxide, bleaching agents or chloride bleaches and peroxides.

Highly flammable or easily flammable products -

warning that the product is more liable to catch fire than others when brought in contact with a spark or naked flame. Products fall into three categories, highly flammable, easily flammable and flammable in nature. Highly Flammable products are not available for purchase in ordinary shops. Products labelled easily flammable or flammable include: ether or petrol, aerosol spray paints, nail varnish or removers, car window de-icers, paint brush cleaning products and air fresheners.

Explosive products -

used for products which may explode either spontaneously or in combination with other substances resulting in accidents, severe burns or destruction of property. Rarely seen on consumer products as this group of substances is not deemed appropriate for sale over the counter.

Environmentally hazardous products -

symbol depicting a devastated landscape with a dead tree and fish, describing products which are poisonous to wildlife and deplete the ozone layer. Products include those containing CFCs, the active ingredients of pesticides, some solvents.

4 Consumer-related pictograms

4.1 Toy safety pictogram

Under the EU Toy Safety Directive, all toys with small parts must carry warnings to inform that they are unsuitable for children under three. The European Co-ordination Secretariat for Standardisation commissioned a pictogram to be developed to convey this message and this is now included in BS EN 71-6: 1995/BS 5665: Part 6: 1995, Safety of Toys, Part 6 - Graphical symbol for age warning labelling.

The pictogram was introduced in 1995 and is currently placed on packaging alongside text, though there are moves to use it as a stand alone pictogram after a currently unspecified introduction period.

The pictogram was developed experimentally and tested on users throughout Europe by the Centre for Safety Research, Leiden University. Eight variants of a pictogram were developed by the European Standards working group, CEN TC 52 WG 6.

The levels of comprehension of the final pictogram varied significantly across Europe and highlighted the difficulties of the cross-European approach and the attainment of the 85% comprehensibility level as required by ISO.

4.2 The exclamation mark

A generic symbol used to highlight a general hazard and usually accompanied by text describing the nature of the hazard. The symbol is usually depicted within a red bordered, white background warning triangle and the symbol itself is black. Described for use in the highway code, BS 5378: safety signs and colours, and ISO 7000: Symbols for use on equipment amongst others, the exclamation mark is a widely used hazard symbol.

4.3 Flammability of furniture regulations

Upholstered furniture must be permanently labelled to show that it meets the fire resistance requirements in the Furniture and Furnishings (Fire) (safety) Regulations 1988 (as amended) as specified by reference to a number of British Standards. These labels do not make use of pictograms. However the Regulations do also require non-permanent “display labels” to be attached to furniture at the point of sale; one of these uses a pictogram of a stylised match and cigarette in black with a green border and red flame on the match.

4.4 Agricultural and gardening products

BS 4964 (Parts 1 and 2), 1993 and ISO 3767 (Parts 1 and 2), 1991 outline the symbols for control markings and displays on tractors and machinery for agricultural and gardening purposes. The Agricultural Engineers Association (AEA) is currently developing pictograms to show complex prescriptive messages such as, “unplug the mains lead from the supply before maintenance or repair” and “wait until moving parts have completely stopped before handling the machine.”

5 Standard certification marks

The pictograms described in the previous section all have a direct relationship to safety, either warning users of dangers or describing some prescriptive action which will have a direct bearing on user safety. This second section of pictograms in common usage focuses on the symbols commonly found on products to show product conformity with European or industrial standards, all which have a bearing on safety as well as quality.

5.1 International standard bodies

- Kitemark (British) - This mark is one of BSI's certification trade marks.
- Keymark (European) - developed by the European Committee for Standardisation (CEN) and the European Committee for Electrotechnical standardisation (CENELEC), and was launched in September 1995. It is a new certification mark to show consumers that a product conforms to European Standards, which cover safety requirements, performance, quality and environmental aspects. It is a registered third party product certification mark jointly owned by CEN and CENELEC.
- The Safety Mark - as with the Kitemark, the Safety Mark can only be used by manufacturers licensed under a Safety Scheme which involves a scheme of strict quality control procedures. It came about as a result of EEC requirements for the safety of electrical equipment. It differs from the Kitemark as it deals with safety factors only, rather than other standardised features of a product.
- The Lion Mark - in 1988 the British Toy and Hobby Manufacturers Association introduced the Lion mark. This is an Association symbol intended to indicate quality and safety of their members' products.
- Double Insulation of Electrical Appliances - his mark is frequently seen on a particular class of household electrical appliances such as hairdryers, portable tools etc. It means that the product has no provision for earthing and therefore the user should take care that the cord is connected correctly to the plug.

5.2 Pictograms standardised within industry

- International Leather mark - the sign of real leather as outlined in BS 2780: 1983. The mark was designed by the International Council of Tanners to replace the various national symbols previously in use.
- The Woolmark - the International Wool Secretariats (IWS) certification mark for products made from pure new wool.

- Pharmaceutical industry - directive 92/27/EEC sets out the requirements for leaflets and labelling and has been implemented in the UK by the Medicines (labelling) Amendment regulations 1992 [SI 1992 No. 3273] and the Medicines (leaflets) Amendment regulations 1992 [SI 1992 No. 3274]. These are amendments to the principle regulations SI 1976 No. 1726. The regulations permit the use of symbols or pictures to explain required particulars, and any other useful health information which relates to the licensed particulars with the exclusion of any element of a promotional nature. The Association of British Pharmaceutical Industry state that there are no standardised pictograms for use on their products. Certain standardised information has to appear on the packaging. Manufacturers have to submit all labels and information leaflets to the Medicines Control Agency before use on the market. Any pictograms are assessed along with the other material.
- Soap and detergent - the European Detergents Association (AIS) and the European Federation (FIFE) through their National Trade Associations have developed a range of standardised pictograms with the aim of simplifying the information on product labels. Two types of pictogram have been designed, one to indicate the application area and the second to depict the method of application. Pictograms were seen a particularly appropriate form of labelling for these products as many workers in the cleaning industry throughout Europe do not have the relevant country language as their first language.
- Food labelling - based on directive 79/112/EEC the Food Labelling Regulations 1984 (SI 1984 no. 1305), implements the laws of the Member States relating to the labelling, presentation and advertising of foodstuffs for sale to the ultimate consumer. This legislation led to the Food Labelling (Amendment) Regulations 1994 which implements EC Directive 90/496/EEC on the nutrition labelling of foodstuffs. Specified information including the nutritional content, best before dates and manufacturers details now have to be placed on the products in some format. This information is usually in text format. With the increasing trends towards marketing information, endorsements and trademarks on products, in conjunction with the required information, there are concerns as to the clarity of the nutritional information.
- Green labelling - refers to the symbols used on products to display information relating to the products content and packaging or related effect on the environment. There is no standardisation of these symbols or legislation supporting the use of them on specific products. The Consumers Association (1990) studied these symbols and found that 60% of shoppers had bought at least one such labelled product on their last shopping trip. Green labelling is used particularly as a marketing tool by some organisations and it is common to find at least one such symbol on the relevant products.

- Furniture labelling - as outlined in BS 5852 and described in “furniture labelling” above.
- Other use of pictogram use on products

The following are examples of non-standardised pictograms displaying product information on packaging:

- Anti-allergenic bed care pictogram
- Heat source use of saucepans and casseroles
- Suitable usage of a particular brand of vacuum cleaners
- Disposable nappies

5.3 Trademarks

The 1994 Trade Marks Act defines a trade mark as being any sign which is capable of being represented graphically and which can in the course of trade, distinguish the goods and services of one undertaking from those of other undertakings.

Such signs may include words, designs, letters, smells and the shape of goods or packaging. The registration of a trade mark grants a statutory monopoly to the holder. It is therefore not possible to register marks which are, or are confusable with words/ symbols which other traders or providers of services should be free to use in the normal course of their business in relation to the same goods or services.

5.3.1 Singular trademarks

The majority of products seen on our shop shelves for purchase have at least one registered trademark on them. Often in the form of a brand name, product name or company name these trademarks are owned by their mother company and may take the form of either abstract pictograms or specified alpha-numeric formats.

5.3.2 Collective trademarks

Trademarks can also be collective marks. Collective marks differ from an “ordinary” trademark in that they are owned by an association or group of traders. Its function is to indicate a trade connection between goods or services and the association owning that mark rather than to differentiate the goods or services of a particular manufacturer or supplier. For example an association of Indian restaurants may allow its members to display a collective mark to show that they belong to that association. Collective marks are often used as endorsements.

5.4 Endorsements

Endorsements are where food seemingly carries an independent stamp of approval by an endorsing body. Examples of the use of this type of mark were studied by the Consumers Association and published in Which? October 1995.

One example of an endorsement is the Vegetarian Society approval symbol which appears on over 2,000 products suitable for eating by vegans. The British Dental Association, the Soil Association and the RSPCA all have respected endorsements on products that comply to the particular association standards. Symbols representing endorsements are becoming more popular by being used as a marketing ploy and some institutions are endorsing products for pure financial gain.

The following is a list of British, European, American and International standards for pictograms, signs and symbols with a relevance to consumer safety.

Appendix B Standards relating to pictograms

1 Product signs and labels

ANSI Z535.4 1991

American National Standard for product safety signs and labels.

(no UK equivalent to date)

Directive 67/548/EEC

Classification, packaging and labelling of dangerous substances.

Directive 88/379/EEC

Classification, packaging and labelling of dangerous substances in general.

BS EN 71-6: 1995
BS 5665: Part 6: 1995

Safety of Toys.

Part 6 - Graphical symbol for age warning labelling.

This part of the European standard specifies requirements for the use and design of a graphical symbol for age warning labelling on toys not suitable for young children under the age of three years of age.

BS EN 23758: 1994
ISO 3758: 1991

Textiles - Care labelling code using symbols

This International standard outlines and specifies the use of a system of graphic symbols, to be used for the permanent marking of textile products, showing the information essential for their proper care.

It includes directions for washing, chlorine-bleaching, ironing, dry cleaning and tumble drying textiles.

2 Public information symbols

These are symbols which are used to provide non-verbal, primarily directional information to the general public. Intended to be understood by a wide variety of people who do not share a common language, they are often used in transport facilities and public areas.

ISO 7001:1990
BS 6034: 1990
ISO 7001-1980: Addendum 1

Specification for public information symbols

These standards deal with the specification of the image content of graphical symbols used for the public.

ISO 7239: 1984 (technical report)

Development and principles for application of public information symbols

This standard specifies some definitions and principles covering the development and application of public information symbols, and should be used as a guide to the application of the International Standard.

ISO 9186: 1989

Procedures for the development and testing of public information symbols

Due to the cultural and technological differences between countries, only the image content of the graphical symbols has been standardised rather than the graphical images themselves. This standard lists the requirements for each of the image contents and shows an example of correct graphical image design.

3 Safety signs

These are signs using pictograms and symbols that carry hazard warnings and safety information usually pertaining to the workplace environment. The standards relevant to the UK which exist in this area are:

BS 5378: Part 1: 1980

Safety signs and colours: Part 1. Specification for colour and design

ANSI Z535.3-1991

American National Standard for Criteria of Safety Symbols

92/58/EWG*92/58/EEC*92/58/CEE

AFNOR/BSI/DIN: 1992

Council Directive Health And Safety Signs At Work

4 Fire protection signs

A more specific area of safety signage deals with the area of fire safety signs. These type of signs have a dual role, that of depicting fire protection information to the general public and to offer more specialist local information to the fire service. The style of signs used follows the specification for safety signs given in BS 5378: Part 1.

ISO 6309: 1987

Fire protection - Safety signs

This standard specifies safety signs for use in the field of fire protection and fire-fighting. Its scope extends to all situations whereby it is necessary to indicate the location or nature of : the means of giving warning of fire and manual controls; means of escape from a fire; means of fire-fighting; means of preventing fire spreading and areas or materials of fire risk.

BS 5499: Part 1: 1990

Fire safety signs, notices and graphic symbols

This standard specifies the characteristics of fire safety signs that are displayed to give information concerning fire precautions, fire equipment and means of escape in case of fire.

BS 1635: 1990

Graphic symbols and abbreviations for fire protection drawings

5 Graphical symbols for use on equipment

Pictograms and symbols are used to provide operating instructions and mark the controls of cars, machinery and other vehicles. Many of the symbols used for this purpose are abstract in nature and need to be translated from the key in the operating instructions. Symbols for standard functions on equipment, such as an on/off switch, are uniform throughout all equipment and should become familiar to users over time.

BS 7324: 1990
ISO 7000: 1989

Graphical symbols for use on equipment

This standard provides a synopsis of graphical symbols which are placed on equipment or parts of equipment of any kind in order to instruct the persons handling the equipment as to its use and operation.

BS 7477: 1991
IEC 416: 1988
ISO 3461-1: 1988

Guide for general principles for the creation of graphical symbols for the use on equipment

This standard specifies the basis for the creation of graphical symbols for use on equipment. It contains rules for designing symbols, including their size and shape, and instructions for their application.

BS 4964: Part 1: 1993
BS 4964: Part 2: 1993
ISO 3767-1: 1991
ISO 3767-2: 1991

Symbols for control markings and displays on tractors and machinery for agriculture and forestry, and on powered lawn and garden equipment.

Part 1. Specification for common symbols

Part 2. Specification for symbols for agricultural tractors and machinery

BS 5817: Part 8: 1990
IEC 574-8: 1979

Specification for audio-visual, video and television equipment systems.

Part 8. Symbols and identification.

BS AU 143c: 1984
ISO 2575 - 1982

Symbols for controls indicators and tell-tales for road vehicles

6 Others

BS EN 20780: 1993
ISO 780: 1985

Packaging - Pictorial markings for the handling of goods

81/916/EWG*81/916/EEC*81/916/CEE
AFNOR, BSI, DIN: 1981

Commission Directive on classification, packaging and labelling of paints, varnishes, printing inks etc.

BS 3951: Part 1: Section 1.6: 1985
ISO 6346- 1984

Freight Containers. Section 1.6 Specification for coding, identification and marking.

76/907/EWG*76/907/EEC*76/907/CEE
AFNOR, BSI, DIN: 1976

Commission directive for the classification, packaging and labelling of serious substances.

81/916/EWG*81/916/EEC*81/916/CEE
AFNOR, BSI, DIN: 1981

Commission directive on classification, packaging and labelling of paints, varnishes, printing inks etc.

80/590/EWG*80/590/EEC*80/590/CEE

Commission directive for symbol accompanying materials in contact with foodstuffs. June 1980.

7 Individual European Standards

The following German national standards deal with pictograms in use for public information. Many cover pictograms not included in ISO 7000, the international standard for public information symbols.

DIN 30 602: Application of graphical symbols

DIN 30 603: Graphic symbols; arrows; survey and association

DIN 32 911: Information signs for passengers of ski-lifts and rope-ways

DIN 32 912: Information signs for skiers on ski slopes

DIN 32 913: Information signs for cross country skiers

DIN 32 914: Information signs for mountain railways and loipes

DIN 66 079: Public information signs. Part 1-5.

DIN 70 005: Motor vehicles: principles for graphic symbol design

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