

Intern aangestuurde masterproef

Comprehensibility and learnability of A.I.S.E. Safe Use Icons

Carole VAN DEN HEUVEL

Masterproef aangeboden tot het behalen van de graad van
Master of Science in het Milieu- en preventiemanagement

Promotor: Filip GERMEYS

Academiejaar: 2013 – 2014

Verdedigd: juni 201

Master's Thesis

Comprehensibility and learnability of A.I.S.E. Safe Use Icons

Carole VAN DEN HEUVEL

Abstract

Aim: The aim of this study was to investigate the comprehension levels of the twelve A.I.S.E. Safe Use Icons and the effect of a brief training on the subsequent short-term and long-term comprehension. *Method:* By means of an open-ended questionnaire, users were tested on their knowledge of the meaning of the symbols and the required action associated with the given symbols. Comprehension tests were administered at three different points in time. First a baseline comprehension test was completed, next, following a short learning phase, comprehension was again tested, finally, five to nine weeks a final comprehension test took place. During the learning phase participants were asked to view a 2-minute video fragment, wherein the twelve symbols with their respective meaning were shown. *Results:* According to a strict definition for the correct meaning of the symbols, 3 out of 12 symbols reached the 67% comprehension criterion proposed by ISO 9186 (7 following a more lenient definition). Following the brief training phase, comprehension levels dramatically improved, with 11 symbols reaching the 67% criterion (both using the strict and more lenient criteria). Comprehension levels decreased five to nine weeks later, but remained well above baseline levels prior to the training. For 3 symbols comprehension rates again dropped below the 67% criterion. The overall comprehension rates at baseline were 39%, 85% immediately after the learning phase and 54% 5-9 weeks later (57, 92 and 76% following the more lenient definition). *Discussion:* The current study provides additional evidence that brief training has a substantial long-term impact on comprehension (here, on average a gain of 15% and 19% following strict or more lenient criterion respectively). The results indicate that a redesign may be desirable for three symbols to ensure better understanding.

Introduction

Producers are responsible for providing safe products on the market. They have to analyse whether the products involve a potential hazard for the user. If potential hazards have been identified during analysis, producers should determine how to control them. There are three specific ways to prevent hazards from harming people. These three ways are placed in a hazard control hierarchy (see Figure 1). The first way to prevent hazards from harming people is to eliminate or to minimize the hazard by for example replacing a hazardous chemical with a safe chemical that of course has the same cost and effectiveness. If eliminating the hazard is not possible, then the best strategy is to guard someone against the hazard. The best way to guard someone against the hazard is to prevent contact between the person and the hazard by for example using personal protective equipment such as gloves or glasses when using a specific product. Like the first strategy, the second strategy is not always possible to apply. In this situation, providing warnings are the third priority, and sometimes training is also included in the hazard control hierarchy (Wogalter, 2006a, 2006b).

Warnings are used to address a variety of risks during the use of a product, when performing a task, or when storage advice is given. Warnings come in many different forms, such as signs, labels, tags, audio and video clips, and generally serve four main goals. First and foremost, warnings serve to inform the user about the safety hazards, so that the right decision can be made in order to avoid getting oneself or others hurt. Second, warnings are used to influence or change the behaviour of the user, so that safety will be improved. The third goal is linked with the second one and is about the fact that warnings are intended to reduce or prevent health problems, accidents, personal injury and damage. And last but not least, warnings are used as a reminder for users that already have been in contact with the hazard (Wogalter, 2006a).

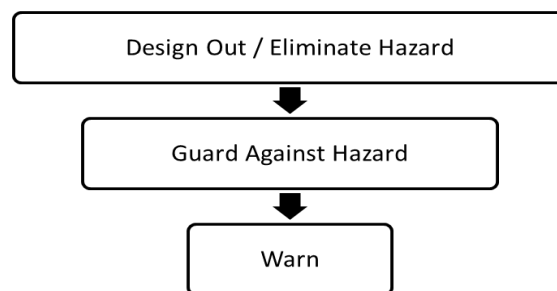


Figure 1. Hazard control hierarchy (Wogalter, 2006a).

Despite the widespread use of warnings, they may not be very reliable and effective in preventing contact with hazards. Actually there are several ways in which a warning could fail to fulfil its purpose. Depending on the circumstances, the user may possibly not hear or see the warning, may not understand it or may not believe it, and as a result may not be motivated to comply with it. To maximize the effectiveness of warnings, they need to be designed well so that the likelihood that warnings perform well in their role in promoting safety is facilitated (Wogalter, 2006a).

The use of warning symbols can however lead to other disadvantages. It may come at a cost, such as an increased risk of incorrect interpretation for graphical representations compared to text (CCITT E.121). Warning signs may also be less efficient in conveying detailed information. For example, simple symbols tend to be more legible compared to detailed symbols. Moreover, the complexities of certain symbols appear to conflict with the guideline that symbols should be brief. But simplicity is not always possible when designing an understandable symbol, that is why sometimes certain details are absolutely necessary to communicate the message adequately. Furthermore, the interpretation of abstract symbols usually requires learning. For example, abstract symbols are images that have a distant relationship to the concept and this means that the process tends to be more effortful than for representational symbols, where the images are closely related to the concept (CCITT E.121; Wogalter, 2006c).

However, the use of warning symbols also offers a number of advantages. First, they have an international character, in the sense that they are not bound to a particular language and they can be understood by everybody even by illiterate persons if well-designed (Böcker, 1996). A second advantage is that the safety message can be communicated and acquired rapidly, again if well-designed (Wogalter, 2006d). Third, they tend to be more legible than texts (Wogalter, 2006e). Fourth, the presence of icons has been shown to improve memory performance (Young & Wogalter, 1988). Finally, the presence of pictograms may also improve the communication of safety information. For example, safety messages tend to be better understood in the presence of a pictogram than without, moreover the perceived risk tends to be higher in the presence of a pictogram (Boelhouwer, Davis, Franco-Watkins, Dorris & Lungu, 2013).

In order to aid developers of warning information, and also to help investigators determine the reason(s) why warnings sometimes fail to be effective, Wogalter (2006f) introduced the *communication-human information processing* (C-HIP) model. C-HIP is a framework that is used to describe the processing of warning information. Figure 2 shows the different stages involved in the warning information process and how these influence the effectiveness of the warning. The model

comprises three main stages. The first stage is the warning information stage, which consists of the information source (sender) sending its message through different channel(s), and delivering it to the receiver. The next stage, the receiver stage, involves several steps in which an individual processes the information. The final stage is whether or not the behavior is appropriately adapted according to the initial warning. According to the C-HIP model, a warning may fail to affect or change the behavior, due to the fact that some information was not successfully processed through the model and was blocked at a certain stage. If essential information does not reach the user, a dangerous situation can arise (Wogalter, 2006f, 2006g).

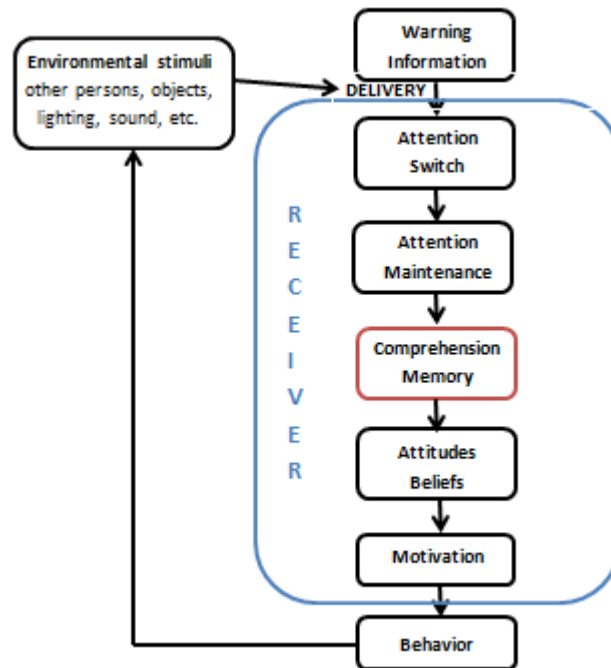


Figure 2. The communication-human information processing (C-HIP) model (Wogalter, 2006f).

The receiver stage incorporates several sub-stages. The first stage is the attention switch stage. This is the stage where the attention is switched from other stimuli, thoughts or tasks to the warning. To make the switch effective, the warning must be noticeable, eye-catching and large relative to its background. The second stage is the attention maintenance stage, which refers to the process of holding attention long enough onto the warning so that users can convert its message. The third stage, which is the main focus of the present study, is the comprehension and memory stage. It refers to the fact that not everybody is able to understand the meaning of the warning or that some warnings are difficult to understand. If previous knowledge or experience stored in long-term memory cannot be activated to decrypt the message, then the warning will be unsuccessfully processed in this stage. This in turn will cause a failure in the further stages of the model. The fourth stage is the attitudes and beliefs stage. Hazard perceptions can influence the information processing at the beliefs and attitudes stage, because the greater the perceived hazard, the more responsive people will be to warnings. If a person does not believe that the warning is relevant, then the warning may fail to fulfill its goal. The purpose of warnings is to change people's beliefs that a hazard is more dangerous than they think or initially thought. The last stage is the motivation stage. It is also important because people should carry out the wanted behavior. There are different factors that can influence the motivation, such as severity of potential injury, social influence, stress and cost of compliance (Wogalter, 2006f, 2006g).

Comprehensibility and learnability

The focus of the present study is on the comprehensibility and learnability of a specific set of symbols. Comprehension is a very important criterion for symbols, because it concerns the degree to which the user understands the warning, based upon the intended meaning the warning is designed to convey (Wogalter, Conzola & Smith-Jackson, 2002). It is also often dependent on information from the past stored in our memory (prior knowledge) (Wogalter, 2006e). But observing a symbol does not ensure that the warning will be remembered at a later time. Therefore symbols should be designed in a manner that is most conducive for enhancing memory of the warning (Young & Wogalter, 1988). Unfortunately, this is often not the case and that is why training could be a useful way to improve comprehension.

A lot of studies have indicated that warning symbols are often poorly understood (Davies, Haines, Norris & Wilson, 1998; Duarte, Rebelo, Teles & Wogalter, 2013). For example, Silver et al. (1995) studied three categories of pictograms ('keep out', 'electrical shock' and 'do not dig') with each five pictograms. While all the 'electrical shock' pictograms and three out of five 'do not dig' pictograms reached the 67% comprehensibility criterion from the ISO standards¹, none of the five 'keep out' pictograms did. Campbell et al. (2004) evaluated 17 in-vehicle safety system signs depicting forward collision, side collision and lane departure warnings. None of these symbols reached an acceptable comprehension rate, with the highest observed comprehension rate being as low as 54%. In a similar vein, Ward, Wogalter and Mercer (2004) found that only 17 of 100 road signs reached the 85% ANSI² comprehension criterion for public symbols.

If symbols are not well understood by the users, a lack of comprehension can result in inappropriate use of products with disastrous consequences in some cases (Leonard & Wogalter, 2000). The reasons why a person may be incapable of understanding the warning are myriad: the information may be too complex or ambiguous; the 'language' of the symbol may not be understandable to the user; there may be time pressures or distractions (Wogalter, 2006i). Moreover, several studies have shown that different factors such as age (Lesch, 2003; Lesch, Horrey, Wogalter & Powell, 2011; Liu & Ho, 2012), gender (Shinar, Dewar, Summala & Zakowska, 2003), educational level (Wang & Chi, 2003), the presence of context (Wolff & Wogalter, 1998), culture (Smith-Jackson & Wogalter, 2000), and level of training may affect comprehensibility.

With respect to the latter, in several studies, Lesch studied the impact of training on warning symbol comprehension which all revealed that simple training improved accuracy and speed of responding on a later comprehension test. For example, Lesch (2003) tested 41 symbols on three different training conditions namely a verbal label condition (a description of the meaning of the symbol was provided), an explanatory statement condition (explanation of the nature of the hazard was provided) and an accident scenario condition (which described an accident or a near miss). All three conditions improved comprehension of the symbols, with the accident scenario producing the best performance, followed by the explanatory statement, and then the verbal label. All three training conditions provided dual codes, which mean that the same information was presented both verbally and symbolically. This was done to stimulate retention. According to the dual-coding hypothesis (Paivio, 1979), there are two types of interconnected processes: verbal (text) and visual (image). Items are thus likely to be stored in both forms. This means for example that words are not only read or heard, but some of them can also evoke specific referent images. The fact that both codes are used will increase the probability of the item recall because the response can be from either code. If one code is forgotten during the retention, memory is supported by the other code. Following up on Lesch's 2003 study, Lesch (2008a) examined 92 symbols comparing a verbal label and accident scenario condition. Again, while both types of training improved performance, a

¹ ISO 9186 specifies methods for testing the comprehensibility of graphical symbols without text. The testing methods consist of two parts, the comprehensibility judgment test and the comprehension test. If the symbol reaches the 67% acceptance criterion, it can be included as a standard icon. The ISO 9186 requires testing in several countries (Wogalter, 2006h).

² ANSI Z535.3 is the American National Standard for Criteria for Safety Symbols. It also consists of two testing methods, the comprehensibility judgment test and the comprehension test. Graphical symbols without text must reach the 85% acceptance criterion and requires no more than 5% critical confusion. The ANSI Z535.3 is only in the U.S. (Ward, Wogalter and Mercer, 2004; Wogalter, 2006h).

higher percentage of correct answers, greater confidence in correct answers, and shorter response times were noted in the accident scenario training. Lesch (2008b) further investigated the potential benefits of an accident scenario training on 34 symbols. The study did not only reveal that comprehension rates improved from 43% to 82%, and that reaction times were reduced by about 2 seconds, but also that level of confidence in correct answers increased by 23%. Chan and Ng (2010) also tested three different training methods, namely paired-associate learning, recall training, and recognition training. The paired-associate learning involved each participant learning a symbol sign and its meaning for 20 seconds. The recall training consisted of two stages. In the first stage all symbols with their referents were shown for 5 seconds each, and in the second stage a recall task was conducted wherein the participants had 10 seconds per symbol to recall the meaning of the symbol. After the 10 seconds, the referent was shown to provide visual feedback. The recognition training also consisted of two stages. In stage one, all symbols, each with their referents, were shown for 5 seconds. In stage two, a recognition task was conducted wherein the participant had 10 seconds to choose the one referent, from five referents, that describes the given sign the best. The study showed that recall training is more effective in enhancing comprehension of safety signs, than paired-associate learning or recognition training.

Several studies have compared the impact of training on comprehension through direct and indirect learnability. While all these studies revealed that the comprehension scores immediately after the training and shortly after the training were higher compared to no training, decreased levels of comprehension were noted when the survey was done a longer period after the training. However, the decreased levels of comprehension still exceeded those prior to training (Lesch, 2003, 2008a, 2008b; Ou & Liu, 2012; Wang & Chi, 2003; Wogalter, Sojourner & Brelsford, 1997).

Overview of the present study

Producers are more and more aware of their responsibility concerning the products they bring on the market. This awareness has not only advantages for their company image, which may in turn influence their sales figures, but also for society by providing more and correct information on the products. Therefore companies must also take all their stakeholders into account such as their consumers, because it is important for a consumer to know the risks associated with the use of a particular product. Moreover, an increasing number of companies tend to support different initiatives towards safety communication on packaging, like for example the initiative of A.I.S.E., which will be explained in the next paragraph. These are positive evolutions, however, due to increased legislation and the trend to use a uniform way of communication, there seems to be a general increase in the amount of information on the packages of consumer products. Consequently, there are concerns that in many cases packaging is becoming cluttered with this information which can confuse the user and have effects on the comprehension (Davies et al., 1998). Furthermore, there are also doubts about the added value, because even with all this information on the packages accidents still occur. In 2013, the Belgian Antidote Centre received 11278 calls for exposure to household products, the victims were: 5148 adults, 5681 children and 481 Animals (personal communication, March 17, 2014).

The focus of the present study is on an initiative of A.I.S.E., namely a specific set of pictograms called the Safe Use Icons (see Figure 3). The acronym A.I.S.E. stands for the International Association for Soaps, Detergents and Maintenance Products. A.I.S.E. is an association that describes its mission as contributing to "a sustainable improvement and development of the quality and comfort of life by means of hygiene and cleanliness" (A.I.S.E., n.d.a). A.I.S.E. has voluntarily and proactively designed a varied set of pictograms. The Safe Use Icons can mostly be found on household products all over Europe and in 25 languages. The safety messages are shown through labelling on packages since 2004. These icons are thus relatively recent and they communicate to the users how to use products in a secure way. They are made freely available by A.I.S.E. to all producers of soaps, detergents and maintenance products who put these products on the EU market. The icons must, of course, comply with the legal and technical guidelines of A.I.S.E. (A.I.S.E., n.d.b).

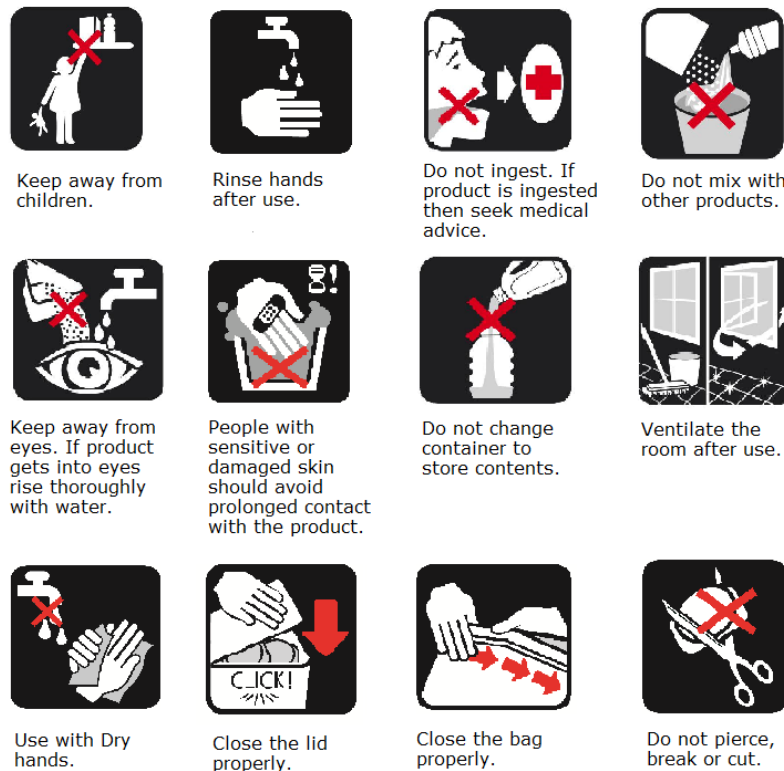


Figure 3. Safe Use Icons (A.I.S.E., n.d.b).

To date, research on the Safe Use Icons is limited. A.I.S.E. conducted two market research studies on their icons. A first study in 2004 was conducted in cooperation with GfK (a market research institute) on heads of households in Germany, United Kingdom, Poland and Italy. The aim of this study was to investigate which symbols would represent the nine verbal messages the best, using as investigation method the comprehensibility judgement test and comprehension test of the international standard ISO 9186. First, a judgment test was conducted in which participants had to estimate the percentage of population they expect would understand the given symbol. Nine referents were tested, each one with four to six different icon design proposals. Based on the 60% acceptance criterion, five referents had at least one variant that reached the criterion and therefore could be recommended as a possible icon. Following this test, a comprehension test was conducted to further evaluate three of the four referents that did not reach the acceptance criterion (between 50% and 60%). Each referent with three different icon design proposals was tested. The participants were asked to describe the meaning of the symbol and the action they would take in response to the given symbol. The answers were judged by three independent judges. The symbol with the highest score above the 60% acceptance criterion was chosen to represent the referent. Only one symbol out of these nine was not further tested, namely "Put refill content in the original container only", because the scores of the initial judgment test were too low, namely below the 50%. The option to use only text for this warning was maintained (A.I.S.E., 2006a). This symbol has thus not been taken into consideration in this research.

In 2010, A.I.S.E. retested their symbols using as investigation method the comprehensibility judgement test and comprehension test of the international standard ISO 9186. The aim of this study was to evaluate the comprehensibility of their symbols. This research confirmed that most of the symbols were relatively well understood by the consumers, only two of the eight icons had to be redesigned, namely the 'Rinse (and dry) hands after use' and the 'People with sensitive or damaged skin should avoid prolonged contact with the product' icons. This result led to an update of the Safe Use Icons in 2011. Also, in October 2012, four new Safe Use Icons were developed that are especially well suited for gel capsules, namely 'Use with dry hands', 'Close the lid properly',

'Close the bag properly' and 'Do not pierce, break or cut' (A.I.S.E., 2014). The two studies mentioned here above resulted in the twelve Safe Use Icons that will be tested in this research.

Most of the Safe Use Icons may already be well known, however, a set of symbols should regularly be (re)tested during its use, because the outcome can reveal new and interesting information. Some revisions can for example be implemented from the gained experience and the feedback gathered from consumers during the testing (A.I.S.E., 2006b). Therefore one of the aims of the present study is to evaluate the comprehensibility of the Safe Use Icons and see if new information will be revealed.

Methods

Participants. Hundred and one persons (56 women, 45 men) participated in the comprehension test at T1. Ninety-nine of these persons (56 women, 43 men) participated in the learnability test at T2 of phase 1. Seventy eight of these 99 persons (44 women, 34 men) participated in the long-term learnability test T3 of phase 2. The sample at T1 of phase 1 included 28 students, 5 retirees, 2 unemployed persons and 66 employees. The students varied between 15 and 25 years of age, the retirees varied between 56 and older than 65 years of age, the unemployed persons varied between 18 and 65 years of age, and the employees varied between 18 and 69 years of age. At T2 of phase 1 two men (workers) from the original sample did not complete the questionnaire because they could not view the video shown during the training. The sample at T3 of phase included 23 students, 4 retirees, 2 unemployed persons and 49 employees.

Materials and procedure. Each participant was requested to fill in two (phase 1 and phase 2) questionnaires in Dutch through Qualtrics. Participants were initially told that the purpose of the questionnaire was to investigate the comprehensibility of certain safety and warning symbols. They were told to describe the meaning of the twelve Safe Use Icons³ and to describe what action they would undertake when they would encounter the given symbol. If they did not know the answer to the question, they were asked to write a question mark in the answer box. Comprehension tests were administered at three different points in time (see Table 1). First a baseline comprehension test was completed, next, following a short learning phase, comprehension was again tested, finally, five to nine weeks a final comprehension test took place. During the learning phase participants were asked to view a 2-minute video fragment, wherein the twelve symbols with their respective meaning were shown. Each symbol associated with its referent was displayed for ten seconds. An open-ended test procedure was used for evaluating both comprehension tests. Both questionnaires were also based on the international standard ISO 9186, which requires reaching 67% comprehension criteria.

On the first page of the first questionnaire (phase 1), the purpose and the sequence of events was explained. Participants were told to first view an example that showed how they should proceed. As example a well-known GHS-symbol was used, namely the 'toxic' symbol and an example answer was given for that symbol, namely "do not inhale, do not swallow, and do not have contact with the skin". After this example, the twelve symbols were shown in a random order generated for each participant. After T1, they were told to view the video. Next, the twelve symbols were again shown in a random order (T2). Following the test, they were asked to fill in some background information (age, highest diploma obtained, gender and professional situation). This was asked to be able to link the data from phase 1 with those of phase 2. The second questionnaire (phase 2) was analogous to the first questionnaire. Again the purpose was explained, but this time no example was given due to the fact that the participants already knew how to proceed. During this second questionnaire the twelve Safe Use Icons were again shown in an individually randomized order. Following this test, they were again asked to fill in the same

³ During the present research, one of the twelve symbols was modified for legal reasons in January 2014. It concerns the "Do not ingest"-icon. The red cross has been changed by a black cross, because the red cross is the trademark of the Red Cross Organization. Users of the A.I.S.E Safe Use Icons should replace the old icon by the new one as soon as possible. It should be fully implemented by June 2015 (A.I.S.E., 2014). Unfortunately, this change has not been taken into consideration in this research, thus the old icon was used in all comprehension tests.

background information. This was asked to be able to link the data from phase 1 with those of phase 2. In both questionnaires the participants were asked to fill in the survey individually.

Table 1

Representation of the overall experimental design and number of participants on the different time points

	Phase 1			Phase 2
	T1 Comprehension test 1	Learning (video)	T2 Comprehension test 2	T3 Comprehension test 3
Participants	101		99	78
Drop-out			2	21

Results and discussion

The criteria used to evaluate the answers of each participant for each symbol were divided into four categories: 'correct in the narrow sense', 'correct in the broad sense', 'incorrect', and 'I don't know'. 'Correct in the narrow sense' means that the given answer corresponds to the meaning of the symbol given by A.I.S.E.. 'Correct in the broad sense' means that the given answer did not fully correspond with its precise description, but that the symbol would be sufficiently understood to assure correct and safe action. The category 'incorrect' are all the answers that were wrong and may bring the safety of the user in danger. If the participants gave no answer or wrote that they did not know the answer, their answer was assigned to the category 'I don't know'. The distinction made between the categories 'incorrect' and 'I don't know' was introduced because both may result in different types of behavior by the participant. People who do not know what a symbol means are more likely to behave safer, compared to people who think that the symbol means something else.

The categorization of all answers to each of the twelve symbols (on T1, T2, and T3) was carried out by the author. First, all answers for each symbol were listed and divided into four categories. If there was doubt as to which category an answer belonged to, the answer was still categorized, but indicated as doubtful. Next, a second person checked this categorization and indicated which descriptions according to him were incorrectly categorized or about which he was in doubt. Then a consensus was jointly sought for these cases, which initially were doubtful or in disagreement. In most cases, thus was case of doubt/disagreement on whether an answer belonged to category 'correct in the narrow sense' or 'correct in the broad sense'. The categorizations of all responses to each of the twelve symbols are shown in Appendix A. According to the international standard ISO 9186, the required level of correct answers should be at least 67%.

Initial comprehension

The initial comprehension test evaluated the extent to which symbols are understood when they are presented without any explanation and any direct prior learning. 101 participants took part in this test. Figure 4 shows a bar chart with the different symbols together with the overall comprehension levels for T1. Using the strict scoring method (i.e., the narrow definitions of the symbols), only 3 symbols reached the 67% ISO criterion, namely Keep away from children 'S1', 86%; Ventilate the room after use 'S8', 70%; and Close the lid properly 'S10', 74%. Four more symbols reached the 67% ISO criterion when the broader scoring method was used (i.e., Do not mix with other products 'S4', Keep away from eyes 'S5', Do not change container to store contents 'S7', and Do not pierce, break or cut 'S12'). The remaining five symbols however, were poorly understood and did not attain the ISO criterion of 67%. The symbols 'Do not ingest' (S3) and 'People with sensitive and or damaged skin should avoid prolonged contact with the product' (S6), reached a score of 52 and 42% respectively using the broad definition. The symbols 'Rinse hands

after use' (S2), 'Use with dry hands' (S9), and 'Close the bag properly' (S11) were correctly understood by less than 25% even when broader definition was used.

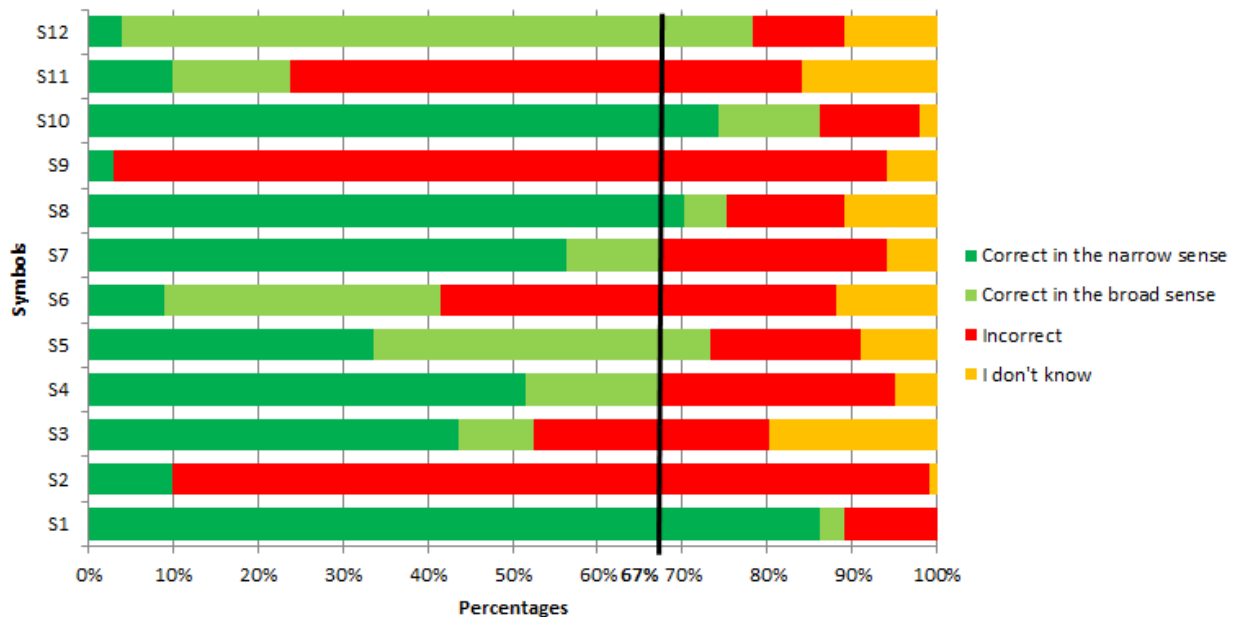


Figure 4. Initial comprehension (T1; n=101). Black line stands for the 67% ISO criterion that depicts the required level of correct answers.

Closer examination of the answer of the five poorly understood symbols revealed that, for symbol 2 ('Rinse hands after use'), people did not really understand that they should rinse their hands *after* use. Most people knew that they *should* rinse their hands, but they did not know exactly *when* it should be done. The symbol does not indicate to rinse hands *after* use of the product. For symbol 3 ('Do not ingest'), some people did not understand the symbol at all and some made a mistake in terms of inhaling and not in terms of ingesting the product. For symbol 6 ('People with sensitive or damaged skin should avoid prolonged contact with the product'), it is clear that the participants perceived the risk as being very high. Participants mainly thought that they were not allowed to make contact with the product, but they did not associate it with a damaged or sensitive skin. For symbol 9 ('Use with dry hands'), the most frequent answer was 'not allowed to wash hands with water but only with a dry towel', which is completely wrong. People are allowed to wash their hands but it is important that their hands are thoroughly dried when using the product. For symbol 11 ('Close the bag properly'), only a few participants described the symbol correctly with emphasis on *close properly*. People are very vague in describing this symbol. Most of the participants think that the symbol is giving instructions on how to open and close the bag. Furthermore, a lot of participants showed confusion on whether it describes an open or close movement. Overall these five symbols show poor initial comprehension. Despite having poor initial comprehension, some symbols may be easy to learn. This will be assessed in the next section.

Direct learnability

Next we evaluate the extent to which symbols are understood after a brief learning moment. For this end, data from T1 (initial comprehension) and T2 (comprehension directly following a learning phase) are compared. Table 2 provides an overview of comprehension rates before and directly following learning, assessed with both the narrow and more lenient criteria (also see Appendix B for detailed description including the categories 'incorrect' and 'I don't know'). A few trends can be observed in the data. First, as expected, for all symbols drastic improvement is

noticed from T1 to T2 (ceiling effects taken into consideration for some symbols). Second, as could be expected, the answers given by participants show a strong shift from 'correct in the broad sense' to 'correct in the narrow sense' (see Appendix B). Third, drastic improvement is observed for each of the five symbols that showed poor initial comprehension (S2, S3, S6, S9, and S11), however, immediate learning and retention of symbol 2 ('Rinse hands after use') remains substandard (66% with the lenient criteria), and S9 ('Use with dry hands') lags somewhat behind the other ten symbols (i.e. 88-98%, mean = 95.6% with the lenient definition). Fourth, despite not being problematic, some symbols' literal meaning (i.e., in the narrow sense) remain hard to learn and directly remember. This is the case for symbols S2 (66%), S5 (67%), S6 (71%), and S9 (78%), which score relatively poor on this aspect as compared to the eight other symbols (i.e., range 88-96%, mean = 92%). In summary, the simple and brief learning intervention was very successful in improving comprehension rates in the short term. This does however not imply that the meaning of the symbols is durably stored. In the next section, long-term retention will be assessed.

Table 2

Overview of comprehension rates before and directly following learning, assessed with both the narrow and broad criteria (T1 & T2; n=99)

	Correct in the narrow sense			Correct in the broad sense (incl. narrow)		
	T1	T2	T2-T1	T1	T2	T2-T1
S1	86%	96%	+10%	89%	96%	+7%
S2	10%	66%	+56%	10%	66%	+56%
S3	42%	89%	+47%	51%	90%	+39%
S4	53%	94%	+41%	69%	98%	+29%
S5	32%	67%	+35%	72%	98%	+26%
S6	9%	71%	+62%	40%	88%	+48%
S7	57%	93%	+36%	68%	97%	+29%
S8	70%	91%	+21%	75%	98%	+23%
S9	3%	78%	+75%	3%	82%	+79%
S10	74%	95%	+21%	86%	97%	+11%
S11	9%	90%	+81%	23%	96%	+73%
S12	4%	88%	+84%	78%	98%	+20%

Long-term learnability

In this section the extent to which symbols are still understood five to nine weeks after phase 1 (T1 & T2) is assessed. 78 of the 99 participants that took part in T1 and T2, took part in test phase 2 (T3). To be able to make a direct comparison between the three tests, only data from these 78 participants were used. Figure 5 shows the overall comprehension levels at T1, T2 and T3, for each symbol separately.

A general observation is that comprehension levels increase from T1 to T2 (illustrating the effect of the intervention), followed by a decline in performance at T3. Comparison of T1 and T3 shows that the comprehension levels at T3 are systematically higher than those at T1, which means that after five to nine weeks an effect of the learning intervention was still present.

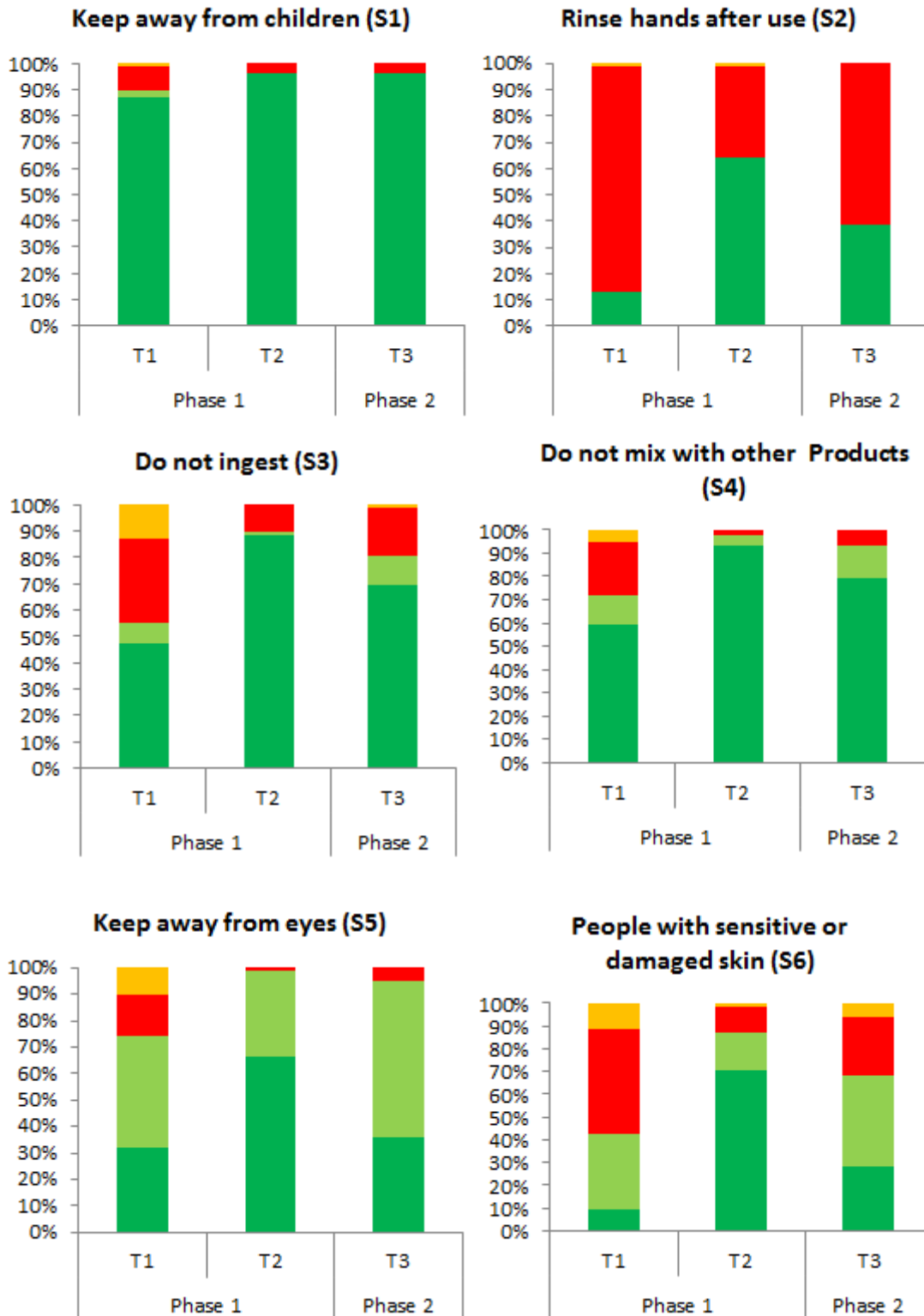




Figure 5. Long-term learnability (T1 & T2 & T3; n=78).

From these results can be concluded that a brief training has clearly a substantial long-term impact on comprehension, with on average a gain of 15% and 19% following strict or more lenient criterion respectively. Six (S1, S3, S4, S7, S8 and S10) out of twelve symbols reached the 67% comprehension criterion using the strict scoring method (i.e., the narrow definitions of the symbols). S3 ('Do not ingest') and S10 ('Close the lid properly') have the lowest score with 69%, while S1 ('Keep away from children') remains the best score on comprehension with 96%. Using the more lenient definition, three more symbols reached the ISO criterion (i.e., People with sensitive or damaged skin should avoid prolonged contact with the product 'S6', 68%; Keep away from eyes 'S5', 95%; and Do not pierce, break or cut 'S12', 88%). However, the simple and brief learning intervention was not very successful in improving comprehension rates in the long term for three symbols. These had again dropped below the 67% comprehension criterion following the strict & lenient definition. The symbols are namely S2 ('Rinse hands after use') with 38%, S9 ('Use with dry hands') with 30%, and S11 ('Close the bag properly') with 59%. These symbols are thus hard to learn and to remember. A modification is therefore desirable to improve comprehension for these three symbols.

Overall assessment of learning

To reach a better understanding of the overall learning assessment, responses at T1, T2 and T3 were analyzed in terms of occurrence. Figure 6 shows a pie chart with the mean percentage of the different combinatorial codes of correct and incorrect answers for T1, T2 and T3 for each symbol and each participant. In this coding, Correct (C) includes the correct answers in narrow and broad sense, while incorrect (I) includes the incorrect and the 'I don't know' answers. There are in total eight combinatorial codes. The first combinatorial code is CCC with a mean percentage of 52,1 of occurrence for each symbol and each participant. It means that the meaning of the symbols with this code was already known by the participants. With other words, the meaning was already stored in the long-term memory prior to the T1 test or it could also mean that the participants directly understood the meaning although it was not learned before. The second combinatorial code is ICC with a mean percentage of 21,8 of occurrence for each symbol and each participant. It means that a simple learning phase resulted in durable storage in the long-term memory, i.e. the symbol was hard to understand but easy to learn. The third combinatorial code is ICI with a mean percentage of 15,2 of occurrence for each symbol and each participant. It means that the participants were able to learn the meaning in the short-term, but it was not stored in the long-term memory. The fourth combinatorial code is III with a mean percentage of 4,9 of occurrence for each symbol and each participant, which means that the participant did not show any sign of learning. The remaining four combinatorial codes (IIC, CIC, CCI and CII) were put together, because the symbols are highly likely not to be understood. It seems that participants have gambled, due to the fact that their responses are not consistent. However, for IIC and CIC, participants might have acquired the meaning of the symbols themselves.

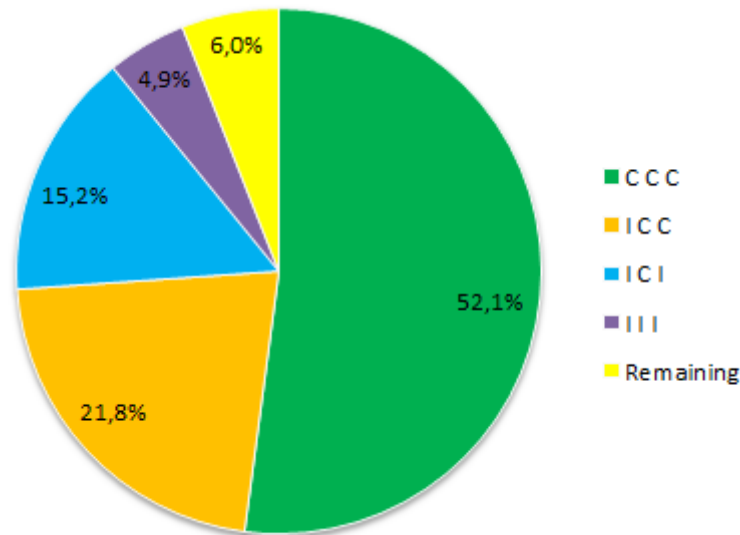


Figure 6. The mean percentage of the different combinatorial codes of correct and incorrect answers for T1, T2 and T3 for each participant and each symbol.

Table 3 provides an overview of the different combinatorial codes in percentages for each of the twelve symbols separately. S1 ('Keep away from children') has 85,9% of correct answers in T1, T2 and T3, which makes it the most understandable symbol of the set, followed by S10 ('Close the lid properly') with 82,1%. However, S3 ('Do not ingest'), S4 ('Do not mix with other products'), S5 ('Keep away from eyes'), S7 ('Do not change the container to store contents'), S8 ('Ventilate the room after use') and S12 ('Do not pierce, break or cut') are also well understandable when taking CCC and ICC into account. The percentages of S6 ('People with sensitive or damaged skin should avoid prolonged contact with the product') are scattered throughout the three combinatorial codes (CCC, ICC and ICI), and S9 ('Use with dry hands') has the highest percentage on no durable learning with 51,3%, which again confirms that both symbols are hard to learn and to remember. Symbol 2 ('Rinse hands after use'), 9 ('Use with dry hands'), and 11 ('Close the bag properly') have a very low percentages of correct answers. Besides symbols 2 and 9 have the highest percentages of incorrect answers at T1, T2 and T3 with 26,9% and 14,1% respectively. Those symbols have thus clearly poor comprehension.

Table 3

The different combinatorial codes in percentages for each of the twelve A.I.S.E. Safe Use Icons

		S1	S2	S3	S4	S5
All correct	CCC	85,9	5,1	51,3	65,4	71,8
Durable learning	ICC	7,7	26,9	24,4	25,6	20,5
No durable learning	ICI	1,3	25,6	10,3	0,0	3,9
All wrong	III	0,0	26,9	5,1	1,3	0,0
Remaining	CCI,IIC,CIC,CII	5,1	11,5	7,7	6,4	2,6

	S6	S7	S8	S9	S10	S11	S12	Mean
CCC	35,9	59,0	75,6	2,6	82,1	20,5	70,5	52,1
ICC	21,8	21,8	16,7	23,1	7,7	35,9	15,4	21,8
ICI	19,2	10,3	3,9	51,3	6,4	30,8	6,4	15,2
III	5,1	0,0	1,3	14,1	1,3	3,9	0,0	4,9
Remaining	12,8	7,7	1,3	3,8	2,6	5,1	5,1	6,0

Figure 7 shows the efficiency of the long-term learnability in percentage for each of the twelve symbols. S2, S6 and S9 have the lowest long-term learnability score with 28%, 34% and 24% respectively. For S11 and S3, S10, the scores are slightly better with 48%, 49% and 44% respectively, but still moderate compared to the other symbols, which are ranged between 52% and 77%, with S12 as the least efficient (52%), S7 and S1 (54% and 57%) in between, and S8, S5 and S4 as particularly well learnable in the long-term (71%, 74% and 77%). The average long-term learning efficiency is 46%, which means that almost one chance out of two a simple method ensures long-term learnability, which is not bad at all for a 2-minute video fragment. Note that long-term learnability is based on direct learnability (as a prerequisite for long-term learnability) and long-term storage.

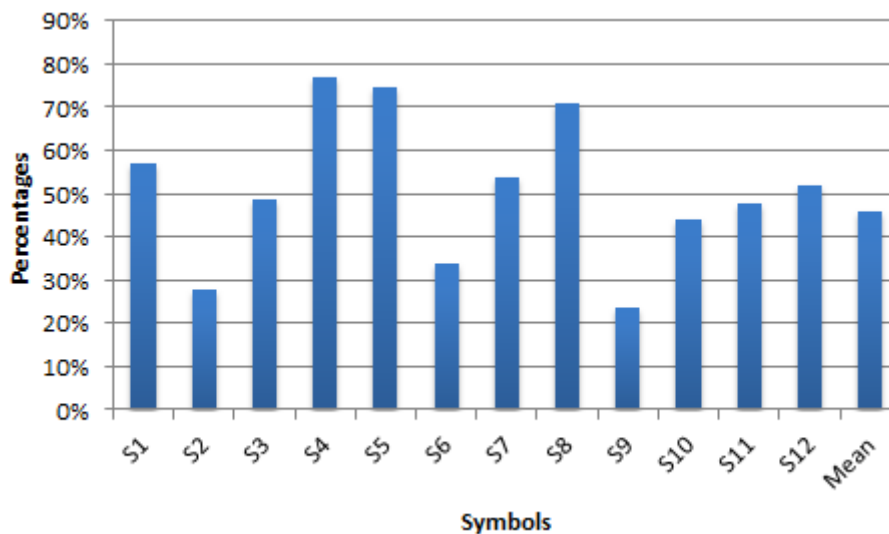


Figure 7. Efficiency of the long-term learnability in percentages for each of the twelve symbols.

Conclusions

The aim of this study was to investigate the comprehension levels of the twelve A.I.S.E. Safe Use Icons and the effect of a brief training on the subsequent short-term and long-term comprehension. It is suggested that warnings are intended to convey safety information to the user. However, the results of the initial comprehension test indicate that only five out of the twelve Safe Use Icons were not well comprehended. Moreover, only three out of twelve symbols reached the 67% comprehension criterion using the strict scoring method (7 following a more lenient definition). Nevertheless, the current study provided additional evidence that brief training has a substantial long-term impact on comprehension (on average a gain of 15% and 19% following strict or more lenient criterion respectively). Training did clearly increase the number of symbols meeting the ISO criteria from 7 at T1 to 11 at T2 (both using the strict and more lenient criterion). However, the comprehension levels decreased from T2 to T3, but were still higher than the comprehension levels at T1, which means that after five to nine weeks an effect of the learning intervention was still present. Nine out of twelve symbols reached the comprehension criterion at T3 (using the strict and more lenient criterion). The overall comprehension rates at baseline were 39%, 85% immediately after the learning phase and 54% 5-9 weeks later (57, 92 and 76% following the more lenient definition).

If existing symbols cannot be improved or redesigned, then training should be done. Training can be short, to the point and really effective, providing significant better results in overall comprehension. However, some training may not be effective because some concepts are not

amenable to clear symbolic representations. It is important to mention that training should not be used as a substitute for designing better symbols, because training cannot be expected to reach everyone. Besides training programs are expensive to develop and implement. It is far better to make more efforts to design or redesign symbols based on testing to ensure correct comprehension of the symbols (Ward, Wogalter & Mercer, 2004). Moreover, changing the symbols is very important because people tend to ignore repeated visual images over time and thus improving or redesigning symbols can have a benefit to capture the attention again (Duarte, Rebelo, Teles & Wogalter, 2014).

Of course further research is needed on the Safe Use Icons. Future research should look at the role of the A.I.S.E. Safe Use Icons on the risk perception and determine whether they are perceived high or low. This could also be done in combination with the GHS-symbols (Globally Harmonised System of Classification and Labelling of Chemicals), because these can often be found together with the A.I.S.E Safe Use Icons on household products. Likewise, we could investigate if an addition of a symbol increases or decreases the risk perception. Also it could be a good idea to include more countries in the testing of those symbols as the ISO 9186 requires (Wogalter, 2006h).

References


- Böcker, M. (1996). A multiple index approach for the evaluation of pictograms and icons. *Computer Standards & Interfaces*, 18, 107-115.
- Boelhouwer, E., Davis, J., Franco-Watkins, A., Dorris, N., & Lungu, C. (2013). Comprehension of hazard communication: Effects of pictograms on safety data sheets and labels. *Journal of Safety Research*, 46, 145-155.
- Campbell, J. L., Hoffmeister, D. H., Kiefer, R. J., Selke, D. J., Green, P., & Richman, J. B. (2004). *Comprehension testing of active safety symbols* (SAE paper 2004-01-0450). Retrieved on 21 February 2014 from University of Michigan Transportation Research Institute (UMTRI) website: <http://www.umich.edu/~driving/publications/Campbell%202004-01-0450.pdf>
- Chan, A. H. S., & Ng, A. W. Y. (2010). Effects of sign characteristics and training methods on safety sign training effectiveness. *Ergonomics*, 53(11), 1325-1346.
- Comité Consultatif International Téléphonique et Télégraphique [CCITT] (1988). *Recommandation E.121 : Pictogrammes et symboles destinés à venir en aide aux usagers du service téléphonique* (E. 121). Retrieved on 24 February 2014 from Union Internationale des Télécommunications website: http://www.itu.int/rec/dologin_pub.asp?lang=e&id=T-REC-E.121-198811-S!!PDF-F&type=items
- Davies, S., Haines, H., Norris, B., & Wilson, J. R. (1998). Safety pictograms: Are they getting the message across? *Applied Ergonomics*, 29, 15-23.
- Duarte, E., Rebelo, F., Teles, J., & Wogalter, M. S. (2014). Safety sign comprehension by students, adult workers and disabled persons with cerebral palsy. *Safety Science*, 62, 175-186.
- International Association for Soaps, Detergents and Maintenance Products [A.I.S.E.] (n.d.a). *Who we are*. Retrieved on 10 March 2014 from <http://www.aise.eu/about-aise/who-we-are.aspx>
- International Association for Soaps, Detergents and Maintenance Products [A.I.S.E.] (n.d.b). *Safe use icons - update 2014*. Retrieved on 10 March 2014 from <http://www.aise.eu/library/artwork/safe-use-icons---update-2014.aspx>
- International Association for Soaps, Detergents and Maintenance Products [A.I.S.E.] (2006a). *Consumer Research on Safe Use Icons* [Brochure]. Brussels: A.I.S.E. & GfK
- International Association for Soaps, Detergents and Maintenance Products [A.I.S.E.] (2006b). *Main steps of the validation process of the A.I.S.E. safe use icons* [Brochure]. Brussels: A.I.S.E.
- International Association for Soaps, Detergents and Maintenance Products [A.I.S.E.] (2014, January). *Safe use icons: guidelines for on pack use*. Retrieved on 10 March 2014 from http://www.aise.eu/documents/document/20140129161815-final_draft_aise_safe_use_guidelines_revjan2014.pdf
- Leonard, S. D., & Wogalter, M. S. (2000). What you don't know can hurt you: Household products and events. *Accident Analysis and Prevention*, 32, 383-388.
- Lesch, M. F. (2003). Comprehension and memory for warning symbols: Age-related differences and impact of training. *Journal of Safety Research*, 34, 495-505.


- Lesch, M. F. (2008a). A comparison of two training methods for improving warning symbol comprehension. *Applied Ergonomics*, *39*, 135-143.
- Lesch, M. F. (2008b). Warning symbols as reminders of hazards: Impact of training. *Accident Analysis and Prevention*, *40*, 1005-1012.
- Lesch, M. F., Horrey, W. J., Wogalter, M. S., & Powell, W. R. (2011). Age-related differences in warning symbol comprehension and training effectiveness: Effects of familiarity, complexity and comprehensibility. *Ergonomics*, *54*(10), 879-890.
- Liu, Y.-C., & Ho, C.-H. (2012). The effects of age on symbol comprehension in central rail hubs in Taiwan. *Applied Ergonomics*, *43*, 1016-1025.
- Ou, Y.-K., & Liu, Y.-C. (2012). Effects of sign design features and training on comprehension of traffic signs in Taiwanese and Vietnamese user groups. *International Journal of Industrial Ergonomics*, *42*, 1-7.
- Paivio, A. (1979). Stimulus attributes and memory. In A. Paivio (Ed.) *Imagery and verbal processes* (pp. 177-243). New Jersey (USA): Lawrence Erlbaum Associates.
- Shinar, D., Dewar, R. E., Summala, H., & Zakowska, L. (2003). Traffic sign symbol comprehension: A cross-cultural study. *Ergonomics*, *46*(15), 1549-1565.
- Silver, N. C., Wogalter, M. S., Brewster, B. M., Glover, B. L., Murray, L. T. A., Tillotson, C. A., & Temple, T. L. (1995). Comprehension and perceived quality of warning pictorials. *Proceedings of the Human Factors and Ergonomics Society*, *39*, 1057-1061.
- Smith-Jackson, T. L., & Wogalter, M. S. (2000). Users' hazard perceptions of warning components: an examination of colors and symbols. *Proceedings of the International Ergonomics Association & the Human Factors and Ergonomics Society Congress*, *44*(6), 55- 58.
- Wang, A.-H., & Chi, C.-C. (2003). Effects of hazardous material symbol labeling and training on comprehension according to three types of educational specialization. *International Journal of Industrial Ergonomics*, *31*, 343-355.
- Ward, S. J., Wogalter, M. S., & Mercer, A. W. (2004). Comprehension and training of international road signs. *Proceedings of the Human Factors and Ergonomics Society*, *48*, 2104-2108.
- Wogalter, M. S., Sojourner, R. J., & Brelsford, J. W. (1997). Comprehension and retention of safety pictorials. *Ergonomics*, *40*(5), 531-542.
- Wogalter, M. S., Conzola, V. C., & Smith-Jackson, T. L. (2002). Research-based guidelines for warning design and evaluation. *Applied Ergonomics*, *33*, 219-230.
- Wogalter, M. S. (2006a). Purposes and scope of warnings. In M. S. Wogalter (Ed.) *Handbook of Warnings* (pp. 3-9). Mahwah (USA): Lawrence Erlbaum Associates.
- Wogalter, M. S. (2006b). Research on warning signs. In M. S. Wogalter (Ed.) *Handbook of Warnings* (pp. 147-158). Mahwah (USA): Lawrence Erlbaum Associates.
- Wogalter, M. S. (2006c). Warning symbols. In M. S. Wogalter (Ed.) *Handbook of Warnings* (pp. 159-176). Mahwah (USA): Lawrence Erlbaum Associates.
- Wogalter, M. S. (2006d). Attention switch and maintenance. In M. S. Wogalter (Ed.) *Handbook of Warnings* (pp. 245-257). Mahwah (USA): Lawrence Erlbaum Associates.


- Wogalter, M. S. (2006e). Comprehension and retention of warning information. In M. S. Wogalter (Ed.) *Handbook of Warnings* (pp. 267-277). Mahwah (USA): Lawrence Erlbaum Associates.
- Wogalter, M. S. (2006f). Communication-Human Information Processing (C-HIP) model. In M. S. Wogalter (Ed.) *Handbook of Warnings* (pp. 51-61). Mahwah (USA): Lawrence Erlbaum Associates.
- Wogalter, M. S. (2006g). Methods and procedures in warning research. In M. S. Wogalter (Ed.) *Handbook of Warnings* (pp. 23-33). Mahwah (USA): Lawrence Erlbaum Associates.
- Wogalter, M. S. (2006h). U.S. and International Standards for Safety Symbols. In M. S. Wogalter (Ed.) *Handbook of warnings* (pp. 477-486). Mahwah (USA): Lawrence Erlbaum Associates.
- Wogalter, M. S. (2006i). Warning source. In M. S. Wogalter (Ed.) *Handbook of Warnings* (pp. 111-122). Mahwah (USA): Lawrence Erlbaum Associates.
- Wolff, J. S., & Wogalter, M. S. (1988). Comprehension of pictorial symbols: Effects of context and test method. *Human Factors*, 40(2), 173-186.
- Young, S. L., & Wogalter, M. S. (1988). Memory instruction manual warnings: Effects of pictorial icons and conspicuous print. *Proceedings of the Human Factors Society*, 32, 905-909.

Appendix A


Categorizations of responses


Symbol 1 : Buiten bereik van kinderen bewaren.	
	<p>1</p> <p>Buiten bereik van kinderen bewaren. Zorg dat gevaarlijke producten veilig wegstaan van kinderen. Verboden om gevaarlijke producten op kindelhoogte te plaatsen. Producten plaatsen waar kinderen niet bij kunnen. Gevaarlijke producten buiten kinderbereik zetten. Gevaarlijk producten ver uit de buurt van kinderen zetten. Gevaarlijke producten uit de omgeving van kinderen houden. Product niet op hoogte bewaren, die door kinderen kan worden bereikt. Ervoor zorgen dat de producten ergens staan waar kinderen niet aankunnen. Zorgen dat kinderen niet aan dit product kunnen. Buiten bereik van kinderen houden, dus op een hoge plaats opbergen, in een veilig afgesloten kast opbergen. Producten weghouden van kleine kinderen. Gevaarlijk voor kinderen, ik zou het product op een hoogte plaatsen. Niet in bereikbaarheid van kinderen zetten. Kinderen mogen hier niet aan komen, niet in de buurt van kinderen laten. Producten op beveiligde plaatsen buiten het bereik van kinderen plaatsen. Opbergen buiten bereik van kinderen. Het product niet laten waar kinderen eraan kunnen. Gevaarlijke producten onbereikbaar voor kinderen plaatsen. Slaag het product hoog genoeg op buiten het bereik van kinderen. Niet op een plaats zetten die bereikbaar is voor kinderen. Op veilige afstand van kinderen bewaren. Ergens plaatsen waardoor kinderen met dit product niet in aanraking komen. Producten op een zodanige hoogte plaatsen dat kinderen er niet aan kunnen. Product veilig weghouden bij kinderen. Ontoerijkbaar voor kinderen houden. Niet binnen bereik van kinderen bewaren.</p>
	<p>0</p> <p>Kinderen niet aan producten laten komen. Hou kinderen uit deze ruimte waar waarschijnlijk gevaarlijke producten staan. Kinderen mogen aan dit product niet aankomen.</p>
	<p>-1</p> <p>Wat op het schap staat is gevaarlijk voor kinderen. Niet aan de plank trekken/niet aankomen. Niet voor kinderen. Niet geschikt voor kinderen. Kinderen mogen hier niet aan komen. Verboden aan te raken voor kinderen. Kinderen in de gaten houden bij dit symbool. Niet van de rekken halen. Gevaar voor vallende voorwerpen/geen zware voorwerpen op rekken leggen. Plaats alle kindvriendelijke spullen op bereikbare hoogte. Niets boven het hoofd dragen. Kinderen geen dienbladen laten dragen. Geen gevaarlijke stoffen boven kinder hoogte plaatsen. Kinderen vermijden. Schap onbereikbaar voor kinderen houden.</p>


Symbol 2 : Na gebruik de handen afspoelen.		
	1	<p>Na gebruik de handen wassen. Handen wassen na gebruik. Altijd de handen wassen na aanraking met het product. Spoel je handen met water, na het gebruik van het product. Handen afspoelen na contact met het product. Handen wassen na</p> <p>Na aanmerking product, handen afspoelen. Handen wassen na iedere handeling.</p>
	0	/
	-1	<p>Steeds handen wassen. Handen reinigen/spoelen. Handen met water wassen. Was je handen. Verplicht handen te wassen. Handen proper maken. Gelieve handen te wassen. Opgelet voor contact met de huid. Onder stromend water houden. Water enkel gebruiken om handen te wassen. Niet gebruiken zonder de handen te hebben gewassen. Dit product mag de huid raken. Handen wassen/ niet drinken. Handen bevochtigen met kraantjeswater. Handen wassen (als ze vuil zijn tenminste).</p>

Symbol 3 : Niet inslikken. In geval van inslikken een arts raadplegen.		
	1	<p>Niet inslikken. In geval van inslikken een arts raadplegen. Bij inname van dit product naar het ziekenhuis, niet in mond steken. Niet oraal innemen, indien wel hulpdiensten verwittigen. Niet inslikken, indien toch antigifcentrum bellen. Niet innemen, ga anders naar een hospitaal. Iets mag niet opgenomen worden in de mond, als het toch gebeurt, moet men een doctor raadplegen. Niet oraal slikken en indien het wel gebeurd is naar een dokter gaan. Product niet inslikken, indien wel, dokter contacteren. Indien inslikken van gevaarlijke vloeibare product direct naar de dokter. Indien product wordt ingeslikt, eerste hulp inschakelen. Bij inslikken zich tot dokter wenden. Als je dit product inslikt, moet je naar de spoed. Bij inname van het product onmiddellijk naar het ziekenhuis vertrekken. Bij inslikken ehbo/arts raadplegen. Indien u dit product ingeslokken hebt, dient u de hulpdiensten te contacteren. Bij inname gevaarlijk product rode kruis bellen. Bij inname door de mond eerste hulp zoeken. Bij inslikken van schadelijke producten, EHBO opzoeken. Bij inname onmiddellijk eerst hulp post gaan. Iets verkeerd ingeslikt, hulp zoeken bij arts.</p>
	0	<p>Niet drinken. Niet innemen of inslikken. Niet voor oraal gebruik.</p>
	-1	<p>Medisch product niet inademen. Niet inslikken, enkel voor uitwendig gebruik. Besmette adem/als je ziek bent probeer uit te ademen via neus of draag masker. Niet niezen. Hulppost aanduiding/Bij het inademen van gevaarlijke stoffen zich naar de hulppost begeven. Dit product heeft een medische toepassing en mag niet in de mond</p>

	<p>genomen worden. Stilte, je bent in een hospitaal. Niet laten braken. Niet roepen voor rode kruis. Niets innemen uit deze kast. Niet inademen anders hulpdienst verwittigen. Medicatie niet innemen. Rode kruis waarschuwen. Naar de tandarts gaan. EHBO producten niet inslikken. Niet uitademen in deze richting. Eerste hulp roepen bij ongeval of bijstand. Gevaarlijk medicijn, mag niet zonder voorschrift ingenomen worden.</p>
--	--


Symbol 4: Niet mengen met andere producten.	
	<p>1 Niet mengen met andere producten. Niet meer dan 1 product gelijktijdig gebruiken. Verboden iets toe te voegen aan een zeker product. Producten niet mengen. Niet mengen met een ander kuisproduct. Product niet met andere producten combineren. Producten niet met elkaar mengen, bedoeld voor individueel gebruik. Niet samenvoegen van verschillende producten. Geen twee kuisproducten mengen. Verboden producten te mengen. Dit product niet mengen met een ander. Twee producten mogen niet samengevoegd worden. Geen verschillende producten combineren. Chemicaliën niet mengen. Deze twee producten niet samen gebruiken. Meng deze 2 componenten niet. Deze twee producten niet mengen met elkaar. Beide producten niet samenvoegen.</p>
	<p>0 Niet mengen. Het poeder product niet mengen met vloeibare product. Niet samen mengen. Deze 2 vloeistoffen niet samenvoegen in emmer water. Geen chemische stoffen mengen. Geen giftige stoffen mengen. Meng niet toegelaten. Producten niet samen in water mengen. beide producten niet mengen in water.</p>
	<p>-1 Niet mengen in water. Geen producten aan water toevoegen. Niet oplossen in water. Producten niet aan vloeistof (water?) oplossen/het product in droge vorm gebruiken. Niet tegelijk water en het product gieten. Geen water aan toevoegen. Je mag het product niet mengen met water. Alvorens water toe te voegen, eerst product bijvoegen. Dit product niet bij u water doen. Geen vloeistoffen of poeders in de emmer gieten. Deze producten niet in emmer met water gieten. Niet mengen en niet in water gieten. Vaste stoffen en vloeistoffen niet mengen. Niet mengen van giftige producten (cocktail). Geen melk op uw cornflakes doen. Plaats geen 2 verschillende giftige stoffen in 1 emmer om te kuisen. Bijtende producten, geen gevaarlijke produkten samen zetten.</p>

Symbol 5: Oogcontact vermijden. Bij oogcontact grondig uitspoelen met water.	
	<p>1 Oogcontact vermijden. Bij oogcontact grondig uitspoelen met water. Niet in contact brengen met de ogen. Bij eventueel contact overvoedig spoelen met water. Poeder/substantie niet met ogen in contact laten komen. Indien in aaraking met ogen, ogen uitwassen met water. Vermijd contact met de ogen, indien toch uitspoelen met water. Product niet in aanraking brengen met ogen. Indien dit gebeurt, afspoelen met water. Niet in contact laten komen met de ogen of dadelijk en grondig naspoelen met water indien wel het geval. Contact met ogen vermijden en bij contact spoelen met water. Product niet in de ogen terecht laten komen. Goed uitspoelen met water indien product in contact met de ogen is gekomen. Dit product mag niet in de ogen komen, indien het wel in de ogen komt, direct spoelen met water. Oogcontact vermijden, moest het wel gebeurd zijn: uitspoelen met water. Ervoor zorgen dat het niet in de ogen terecht komt en indien wel, de ogen spoelen met water. Niet in contact met de ogen, indien wel direct een oogdouche of oog uitspoelen.</p>
	<p>0 Bij oogcontact grondig spoelen met water. Oogcontact vermijden, indien oogcontact de arts consulteren. Oog in contact met gevaarlijk product, uitspoelen met water. Als het product in uw oog geraakt, spoelen met water. Oog uitspoelen met water indien je het product in je oog gekregen hebt. Onmiddellijk uit spoelen na contact met de ogen. Niet met het oog in contact brengen. Bij oogirritatie oog spoelen (oogdouche). Brandend voor de ogen, spoelen met water. Gevaarlijk voor ogen goed spoelen.</p>
	<p>-1 Ogen wassen met water (oogdouche). Alles wat gevoelig van de oog kan zijn ermee opletten (gevaarlijk). ogen uitspoelen met water. Product gevaarlijk voor de ogen. Product is gevaarlijk voor de ogen, oppassen voor de ogen. Oog reinigen alleen met water. Geen drinkbaar water/geen water nemen. Oog niet spoelen met water. Product gevaarlijk voor de ogen. Spoelen van de ogen niet met giftige stoffen maar enkel met water. Alleen reinigen met water van de kraan, geen andere vloeistof gebruiken. Oogwater om stof te verwijderen. Dit product niet met water in je ogen doen. Het oog spoelen met water, geen poeder of zalf gebruiken.</p>

Symbol 6: Bij een gevoelige of beschadigde huid, langdurig contact met he product vermijden.	
	<p>1 Bij een gevoelige of beschadigde huid, langdurig contact met het huid vermijden. Bij een wonde aan de handen niet te lang in wasproducten de handen dompelen. Niet te lang hand onderdomplen wanneer wondjes. Niet te lang gebruiken als je een wonde hebt. Langdurige blootstelling aan huid met wonde vermijden. Niet met verwondingen in contact komen gedurende langere periode. Een irriterend product dat bij een te lange contact en bij wondjes moet vermijden.</p>
	<p>0 Niet in contact met wonden.</p>


		<p>Opgepast met contact met wonden. Geen open wonden blootstellen aan de vloeistof. Met een wonde vloeistof vermijden. Niet gebruiken bij beschadigde huid. Verboden/gevaarlijk met wonden in contact te brengen. Slechts tijdelijk je handen in dit product steken (hou tijd in de gaten). Niet te lang met een wonde in de emmer zitten. Je mag niet met een wonde het product gebruiken, ook niet met een plakker aan. Niet te lang gebruiken. Handen niet te lang in de vloeistof laten. Niet te lang in aanraking laten komen met de huid. Niet te lang in contact blijven met het product.</p>
	-1	<p>Kan niet tegen water/niet in het water doen. GSM or smartphone niet in of onder water leggen. Indien ik een plijster op mijn handen zou hebben, een tijd wachten tot ik mijn handen in de wasbak zou steken. Niet wassen. Veronderstellend dat er een vloeistof aanwezig is, niet de handen onderdompelen en al zeker niet met wonden. Gekwetst hand niet in giftige vloeistof plaatsen. Niet aanraken voordat het klaar is, wacht op het signaal om te kunnen aanraken. Kokend water, hand niet in water steken. Gevaarlijke stof voor de huid. Niet met de hand wassen. Product niet nat laten worden. Elektrocutiegevaar. Niet te lang in het water laten. Als je een wondje op je hand hebt kan je je extra verwonden door met je hand in deze vloeistof te gaan. Niet met handen in vloeistof gaan, gevaar op blessure. Toestel niet in het water laten vallen. De handen tot een maximum toegelaten periode in deze vloeistof toelaten. GSM niet in water dompelen. Watergevoelig apparaat? GSM niet wassen. Zien dat de GSM niet in de wasbak valt. Voor medisch gebruikte handschoenen niet in vuilbak. Als je je gewond hebt even wachten voor je in het water gaat. Brandende stof, niet met de handen aanraken. Niet bij gewoon huisvuil werpen. Iets met handen niet wassen. Kan maar beperkt met water in contact blijven anders gaat het stuk. Handen verbranden binnen korte tijd in aanraking met dit vloeibaar product. Niet in de vuilbak gooien, naar het containerpark brengen. Bij contact gevaarlijk product niet aanhoudend contact blijven, zo snel mogelijk contact stoppen. Plakker niet te lang in water houden.</p>

Symbol 7: Het product in de oorspronkelijke verpakking bewaren.


	1	<p>Het product in de oorspronkelijke verpakking bewaren. Gevaarlijke producten in de juiste fles laten. De substantie in de huidige fles laten. Product te bewaren in daarvoor voorziene verpakking. Het product in de oorspronkelijke flacon bewaren. Vloeistof in de originele fles laten. Niet overgieten in andere container/fles. Niet in een ander fles gieten. Inhoud niet in een andere fles mag gieten. Het product niet in een ander recipiënt overplaatsen.</p>
---	---	---

		<p>De inhoud steeds in dezelfde bus houden. Product bewaren in de originele container. In de originele verpakking bewaren. Laat dit product in de originele fles. Product moet in oorspronkelijke verpakking blijven. Originele verpakking houden.</p>
	0	<p>Niet overgieten. Giet deze vloeistof niet in dat bepaald recipient (recipient niet bedoeld voor deze vloeistof). Product niet overgieten in plastieke flessen zonder etiket. vloeistof niet overgieten in een fles.</p>
	-1	<p>Niet in pet fles gieten gevaarlijk product. Niet navulbaar. Niet bijvullen. Fles niet vullen. Producten niet samenvoegen. De vloeistoffen niet samenvoegen in een fles. Resten van product niet weggieten in de verzamelcontainer. Niet drinkbaar. Niet in plastiek fles gieten. Fles niet hergebruiken. Niet mengen. Niet mengen met andere producten. Geen vloeistof in deze fles gieten. Bepaalde producten mogen niet in een plastic recipiënt. Product niet in een plastieke fles bewaren.</p>

Symbol 8: Na gebruik de ruimte ventileren.

	1	<p>Na gebruik de ruimte ventileren. Na proper maken, raam openen voor verluchting. Zorg voor de nodige verluchting na het kuisen. Na schoonmaak ramen openzetten voor doorluchting. Verluchten na/tijdens het kuisen/gebruiken van het product. Verluchten na het reinigen (raam openzetten). Na gebruik van kuisproducten kamer ventileren. Na het kuisen raam openzetten. Hier wordt gepoest, ramen openzetten zodat lucht kan circuleren. Na gebruik, ruimte voldoende verluchten. Ruimte verluchten na gebruik. Na het poetsen verluchten. U moet de lucht binnenhuis verfrissen na het schoonmaken. Laten verluchten na het kuisen. Het raam openzetten na het gebruik van producten. Goed verluchten na het poetsen. Na het reinigen, de kamer verluchten. Na het kuisen voor de nodige luchtcirculatie zorgen door het raam open te zetten. Goede ventilatie na het kuisen met een kuisproduct. Na het poetsen met het product, dien je de kamer te ventileren. Na het gebruik van het product/tijdens het kuisen voldoende laten verluchten. Na gebruik lucht laten circuleren. Na het poetsen de vensters open zetten om te ventileren. Na het poetsen moet er goed verlucht worden. Na schoonmaken kamer verluchten. Ruit openen na gebruik voor een betere afvoer van de geurstoffen. Het venster opendoen na de vloer gekuist te hebben. Na vloer schoon te maken, raam openen voor verluchting.</p>
	0	<p>Genoeg ventilatie voorzien. Verluchten. Te gebruiken in verluchte ruimte. Ruimte goed ventileren. Bij gebruik van giftige stof, goed ventileren.</p>

		Raam open zetten zodat giftige elementen de ruimte verlaten.
	-1	Na het poetsen goed verluchten voor beter resultaat. Gepoetst venster naar buiten opendraaien. Na kuisen venster open en toe doen. Kuiswater niet buitengieter. Poetsmiddel voor ramen en vloeren. Raam sluiten. Juist gepoetst. Schoonmaakproduct voor binnen en buiten. Na het kuisen (met een bepaald product) glanzen je tegels en ramen. Verfrissen. Gereinigde vloer laten drogen. Drogen van vloer na het kuisen met open venster. Ramen openzetten om te drogen.

Symbol 9: Met droge handen gebruiken.		
	1	Met droge handen gebruiken. Gebruik met droge handen. Niet aanraken met natte handen. Enkel gebruiken met droge handen. Verboden iets met natte handen vast te nemen/zorgen dat de handen droog zijn voordat het product aangeraakt wordt. Niet met vochtige handen bewerken.
	0	Handen goed droog afwrijven. Handen droog houden/handen drogen. Goed afdrogen en zonder druppels.
	-1	Na gebruik, handen afdrogen. Handen enkel drogen met handdoek. Handen met doek afdrogen. Niet wassen maar handen drogen. Droog gebruik, geen water gebruiken. Gebruiken zonder water. Geen drinkbaar water enkel om handen te wassen. Geen stromend water, handen reinigen. Niet in contact komen met water, bij eventueel contact handen afdrogen. Handen niet met water wassen, maar met een reinigingsdoekje. Niet met water spoelen maar droog afwrijven. Indien je in aanraking bent gekomen met een zeker product, gelieve de handen te wassen. Water/kraan niet gebruiken. Kraan niet gebruiken, niet van drinken, ook niet handen wassen, maar doekje gebruiken. Handen droog reinigen. Gelieve uw handen te reinigen zonder water te gebruiken. Geen handen wassen. Het product mag niet met water verwijderd worden. Verboden handen te wassen. Water niet geschikt om handen te wassen. Handen niet wassen onder dit kraantje. Handen niet wassen met dit water. Besmet water, niet aanraken met de handen. De kraan sluiten alvorens de handen te drogen. Water = giftig. Enkel handen drogen met papieren doekje. De kraan niet laten lopen tijdens het afdrogen van de handen. Handen niet wassen met water na gebruik product. Geen zuiver water; het water voor niets gebruiken. De handen niet afspoelen na gebruik.

Symbol 10: Deksel goed sluiten.



1	<p>Deksel goed sluiten. Doos goed sluiten. Doos sluiten totdat u een klik hoort. Verplicht afsluiten. Sluiten tot een hoorbaar geluid aangeeft dat gesloten is. Goed afsluiten. Steeds dicht doen en daarna moet je een geluid horen zodat je zeker bent dat het dicht is. Verplicht zijn om een doos goed af te sluiten. Goed sluiten. De doos goed sluiten na gebruik. Doos goed sluiten, moet overal klikken. Deksel goed dicht. De pot goed toedoen (goed gesloten bij het horen van een click). Duwen en klikken om goed te sluiten. Goed sluiten aan de hand van een click. Controleer dat het deksel goed afgesloten is, je moet een klik horen. Goed duwen tot het horen van een "click" om te sluiten. Goed dicht duwen. Goed vastklikken. Goed dicht drukken.</p>
0	<p>Product in een goed afsluitbare box opbergen. Opbergen in een doos met veiligheidsslot. Tupperware doos is pas goed gesloten als je 'click' hoort. Zo te sluiten/toedoen. Op die manier vastklikken. Op deze manier dicht doen, dichtklikken of verzegelen. Sluiten door te drukken. Duwen om te sluiten. Naar beneden drukken om te sluiten. Naar beneden duwen tot je een klik hoort. Vastklikken van opbergdoos. Doordrukken tot bij het horen van een click.</p>
-1	<p>Een doos die afsluitbaar is met een kliksysteem. Clickdoos. Het deksel van de doos eerst naar beneden klikken alvorens te openen. Om de doos te openen, eerst duwen tot je een click hoort. Waar je moet opendoen. Druk om open te doen. Klein gevaarlijk afval. Click dozen of sluitingen. De doos gesloten als je het deksel naar beneden duwt en een klik hoort. De bak druk je toe naar beneden en is pas echt gesloten als je een klik hoort. Vuikbak sluiten. Dat je de koekjesdoos goed moet toeduwen totdat je een click hoort. Koffer dichtmaken. Hier dicht doen.</p>


Symbol 11: Zak goed sluiten.



1	<p>Zak goed sluiten. Sluit de verpakking goed af. De verpakking goed afsluiten. Verpakking steeds goed afsluiten. Dicht zippen na gebruik. Terug toedoen. Sluit zipper.</p>
0	<p>De zak sluiten met de aanwezige strip. Het zakje dichtdoen met de daartoe voorziene sluiting (hermetisch</p>

	<p>afsluitbaar).</p> <p>De sluiting moet goed worden aangedrukt anders is de verpakking niet gesloten.</p> <p>Zakje sluiten in aangegeven richting.</p> <p>Dichtmaken door op de strip te duwen van rechts naar links.</p> <p>Zakje dicht doen door van links naar rechts te drukken.</p> <p>Je kan deze zak sluiten door in een richting dicht te drukken.</p> <p>Sluiten door in richting van de pijltjes te wrijven.</p> <p>Met de hand langs de rand strijken om te sluiten.</p> <p>Pakje sluiten naar rechts.</p> <p>Duwen in richting van de pijlen om verpakking te sluiten.</p> <p>Sluit in richting van pijl/sluiten.</p> <p>Dichtdoen met de speciale rits.</p> <p>Ritssluiting gebruiken om te sluiten.</p>
-1	<p>Zak op dit manier sluiten.</p> <p>In deze richting verzegelen.</p> <p>Geeft richting aan om te sluiten.</p> <p>Je moet de zak sluiten volgens hoe je het op het symbool kan zien.</p> <p>Hier aandrukken om te sluiten.</p> <p>Hier dichtkleven.</p> <p>Hier sluiten.</p> <p>Van links naar rechts samenvoegen.</p> <p>Op welke manier je iets moet openen.</p> <p>Omschrijving dat het zakje gesloten kan worden door over sluiting te gaan.</p> <p>Richting van het sluiten van het zakje.</p> <p>Dat de zak dicht kan als je er op duwt en over schuift.</p> <p>Hoe een plastic zak sluiten.</p> <p>De verpakking open in dezelfde richting als de aanwijzing van de pijlen.</p> <p>Om iets te openen, deze richting volgen.</p> <p>Enveloppe opendoen.</p> <p>In die richting opendoen.</p> <p>Om dit te openen moet je iets verschuiven.</p> <p>Hersluitbare verpakking.</p> <p>Sluitstrip.</p> <p>Langs de pijltjes kant opendoen.</p> <p>Laten glijden.</p> <p>In die richting plooien.</p> <p>Container voorzichtig openen.</p> <p>Verpakking openen door te trekken/snijden langs de lijn aangeduid door de rode pijltjes.</p> <p>In de richting van de pijltjes scheuren.</p> <p>Open langs deze zijden.</p> <p>Aan deze zijde vastnemen.</p> <p>In die richting openen en afscheuren.</p> <p>Om te openen hier trekken.</p> <p>Naar beneden toe openen.</p> <p>Gevaarlijk, niet aankomen.</p> <p>Open maken.</p> <p>U moet een beweging langs rechts maken.</p> <p>Duwen en naar links glijden.</p> <p>Product terug luchtdicht sluiten met de voorziene sluiting strip.</p> <p>Zak kan dichtgemaakt worden via strip.</p> <p>Verpakking kan opnieuw gesloten worden.</p>

Symbol 12: Niet snijden knippen of doorboren.

	1	<p>Niet snijden, knippen of doorboren. Niet doorbreken of snijden. Verpakking niet openknippen/doorknippen/versnijden. De capsule niet breken, doorknippen, doorsnijden,... De verpakking niet beschadigen.</p>
	0	<p>Niet knippen, maar openen via klaargemaakte openingen. Niet doorknippen. Niet stuk knippen. Verboden er in te knippen. Knip de capsule niet open. Niet openen met schaar. Niet doorsnijden. Geen schaar gebruiken om dit door te knippen. Gelieve de verpakking niet met een scherp voorwerp te openen. Niet in de buurt brengen van scherpe voorwerpen en niet doorknippen.</p>
	-1	<p>Doseringe respecteren. Hoeveelheid niet halveren. Deze verpakking niet openmaken. Verpakking niet gesloten houden, niet openen. Omhulsel niet verwijderen. Condoom niet knippen. Geen handzeep knippen. Niet knippen in medicatie. lamp/batterij (??) niet doorknippen, maar gewoon weggooien. De pil niet in 2 knippen.</p>

Legend:

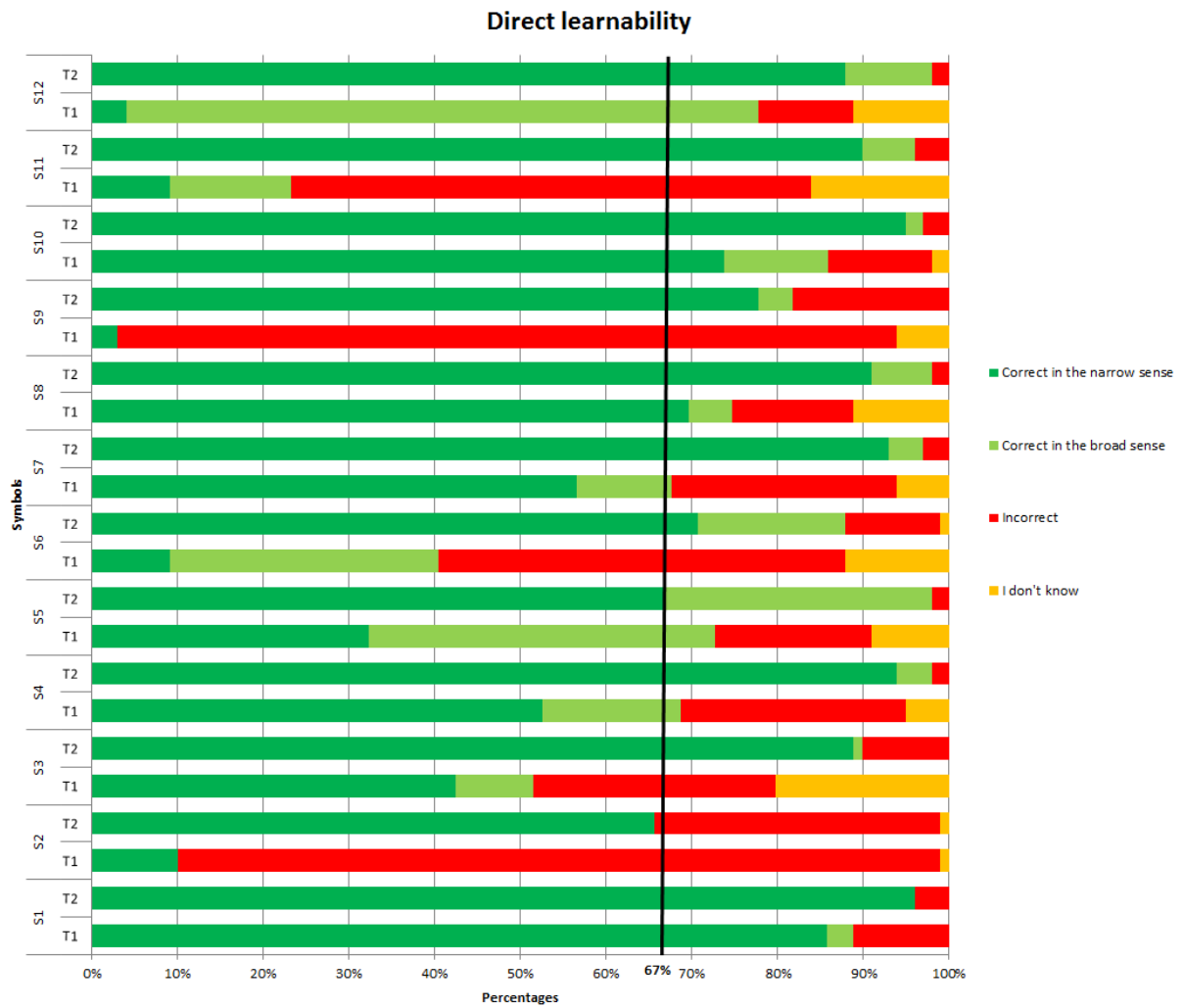
1: correct in the narrow sense

0: correct in the broad sense

-1: incorrect

Appendix B

Overview of comprehension rates before and directly following learning, including the categories 'incorrect' and 'I don't know'



Abstract in het Nederlands

Doel: Deze studie had tot doel de begrijpbaarheid van de twaalf A.I.S.E. Safe Use Icons en het effect van een korte training op korte-termijn en lange-termijn begrijpbaarheid te onderzoeken.

Methode: Gebruikmakend van open vragen, werden gebruikers getest op hun kennis van het symbool en vereiste actie in verband met het gegeven symbool. De begrijpbaarheid werd getest op drie verschillende tijdstippen: een eerste test werd afgenomen en werd onmiddellijk gevolgd door een leermoment, waarna een tweede test werd afgenomen. Vijf tot negen weken later werd een derde test afgenomen. Tijdens het leermoment werden de deelnemers gevraagd om een 2-minutendurende video te bekijken, waarbij de betekenis van de twaalf symbolen weergegeven werden.

Resultaten: Indien een strikte definitie van een correcte betekenis van de symbolen gehandhaafd werd, hebben 3 van de 12 symbolen de door de ISO 9186 vastgestelde begrijpbaarheids criterium van 67% bereikt (7 indien de meer bredere definitie gebruikt werd). Echter, na een korte training zijn de begrijpbaarheidsniveaus sterk verbeterd, waarbij 11 symbolen de 67%-criterium bereikten (gebruikmakend van de strikte en mildere criteria). Vijf tot negen weken later, daalde de begrijpbaarheidsniveaus, maar bleven ruim boven het niveau voorafgaand aan de training. Voor 3 symbolen zijn de begrijpbaarheidsscore opnieuw gedaald tot onder het 67%-criterium. De algemene begrijpbaarheidsscore bij aanvang waren 39%, vervolgens 85% onmiddellijk na de leerfase en 54% 5-9 weken later (57, 92 and 76% volgens de bredere definitie).

Bespreking: De huidige studie verstrekt aanvullend bewijs dat een korte training een substantiële impact heeft op de lange-termijn begrijpbaarheid (hier, gemiddeld een stijging van 15% en 19%, gebruikmakend van respectievelijk de strikte of mildere criterium). De resultaten gaven aan dat een herontwerp wenselijk kan zijn voor drie symbolen, opdat deze correct begrepen zouden worden.