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Warnings and Multilingual Audiences: A Literature Review

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ABSTRACT

Available approaches for communicating warnings and safety information to linguistically diverse audiences have advantages and limitations, but research on this topic is limited. We conducted a semi-systematic literature search to identify peer-reviewed scientific articles addressing communication of product safety information to consumers from diverse language backgrounds. Our review highlights three communication approaches: single-language, bilingual or multilingual, and non-linguistic. Existing research regarding advantages and limitations of each approach is summarized, along with opportunities for future research.

Keywords: Warnings, Labels, Safety information, Non-native speakers, Language barriers, Information design

INTRODUCTION

In a globalized economy, factors such as international trade and immigration have increasingly resulted in companies and organizations seeking methods to communicate warnings and safety information to consumers from diverse language backgrounds. Such entities may not only have to contend with consumers who are non-native speakers of the dominant local language for a given country (e.g., English in the United States), but also consumers of varying native and non-native language proficiency. Combined with wide variation in the regulatory and other mandatory requirements for communicating warnings and safety information across countries and jurisdictions (e.g., Regulation (EU) 2023/1230, Charter of the French Language, CQLR c. C-11), entities may find themselves navigating a complex decision-making process to convey such information to a diverse group of consumers.

The purpose of this review is to examine available human factors literature underlying methods currently available to communicate safety information to multilingual audiences. These methods include presenting warning and safety information in the dominant local language, multilingually, or through non-linguistic communication methods, such as through images or safety symbols. For each communication method, we discuss some advantages and limitations when communicating with linguistically diverse audiences, as well

as available research regarding the extent to which consumers may notice, comprehend, recall, consider, and ultimately comply with the provided safety information.

METHODOLOGY

We conducted a semi-systematic literature search to identify peer-reviewed, scientific articles that discuss communication of warning and safety information with linguistically diverse audiences. Specifically, we searched multiple databases such as Google Scholar, PubMed, the Proceedings of the Human Factors and Ergonomic Society Annual Meeting, and ResearchGate, and used the "cited by" feature in Google Scholar, to identify relevant work. Our review was also informed by our education, training, and experience providing consulting services regarding warnings in a variety of regulatory environments. Early in the review, we identified three main communication methods: single-language, bilingual or multilingual, and non-linguistic. Additional literature searches were conducted for research specific to each of these types of communications. For single-language communications and bilingual or multilingual communications, typical keywords searched included "Warnings," "Safety Information," "Product Labels," "Packaging," "Translation," "Bilingual," "Multilingual," and "Non-native." For non-linguistic communications, additional keywords included "Symbols" and "Non-linguistic."

SINGLE-LANGUAGE COMMUNICATIONS

One identified communication method is to present warnings and safety information in the single, dominant language of the area in which the product is being sold. This is often a method of satisfying regulatory requirements. For example, in the United States, workplace labels for hazardous chemicals must be provided in English, although other languages may also be included "if appropriate" (29 CFR §1910.1200(f)(2)). Single-language labels may also be helpful when the consumer base is known or reasonably could be assumed to be at least somewhat proficient in comprehending the local language. For example, to be eligible for a flight instructor certificate or rating in the United States, individuals are required to be able to read, speak, write, and understand English (14 CFR §61.183(b)), and warnings and safety information communicated only in English would be expected to be appropriate for this population.

However, for users who are not proficient in the dominant local language, presenting warnings and safety information in a single language may provide limited accessibility. One option available in such instances is to use simplified or modified language specifically tailored to non-native speakers. For example, some industries have chosen to use Simplified Technical English (STE), originally released in the 1980s in the aerospace industry, which became an international standard in 2025 (ASD-STE100). STE consists of a controlled dictionary of approximately 900 approved words and a set of writing rules, with the intention of disambiguating complex technical

instructions (ASD-STE100). Research has found that STE can maintain information density of general written English while reducing linguistic complexity and improving readability scores (Disborg, 2007; Wang and Friginal, 2025). However, research on the effectiveness of STE in improving comprehension and reducing language errors is still limited; further work could better examine the circumstances under which STE may be helpful as a tool to communicate with non-native English audiences.

Among non-native speakers, there is also variance in the extent to which such speakers become proficient in their non-native language, based on factors such as individual aptitudes for language acquisition, regional variance in bilingual education, and job demands (Birdsong, 2004; EF EPI, 2024). However, there is evidence that non-native speakers can disambiguate differences in safety information provided in their non-native language, such as signal words. For example, signal words such as WARNING and CAUTION can communicate differences in hazard severity across non-native and native/high-proficiency populations (Wogalter and Silver, 1995). Other research has suggested that users with little to no proficiency in the language may fail to fully comprehend the information or may disregard it entirely (Herrera et al., 2019). The use of unfamiliar jargon or excessively long messages in a non-native language can serve as an additional communication challenge (Rojak and Handayani, 2023). While some low-proficiency readers may rely on other individuals to translate the information for them or attempt to translate it themselves (Herrera et al., 2019), research conducted in the domain of health communication suggests that translations provided by friends or family or by frequently used translation platforms such as Google Translate may be variably accurate in translating safety and health information (e.g., Patil and Davies, 2014; Taira et al., 2021). Research also suggests that non-native speakers may attempt to find alternate sources of information in their native language, although such sources may be missing safety-critical information specific to the original message (Gao et al., 2022).

BILINGUAL OR MULTILINGUAL COMMUNICATIONS

Providing warning information in two or more languages can accommodate different native language backgrounds of the target audience and allow for a single product to address language needs of multiple audiences. In North America, labels may include parallel information in English, French, and/or Spanish to simultaneously achieve compliance with regulations across country borders and promote accessibility for diverse populations. For example, the Canadian Consumer Packaging and Labelling Regulations (CPLR) require that product information, such as identity and net quantity declarations, be displayed in both English and French for non-food and non-drug items (C.R.C., c. 417). According to the Charter of the French Language by the National Assembly of Quebec, such materials must display French content with equal prominence to English content, and "every inscription on a product, on its container or on its wrapping, or on a document or object supplied with it, including the directions for use and warranty certificates, must be drafted in French […] no inscription in another language may

be given greater prominence than that in French or be available on more favourable terms." In the United States, such translations are not typically required by regulation. For example, while the U.S. Occupational Safety and Health Administration (OSHA) encourages employers with Spanish-speaking workers to provide notices in Spanish, such translation is not required by regulation (OSHA, 2004).

While these examples highlight the potential for multilingual communication to promote accessibility across diverse populations, little is known about the impact of providing warnings and safety information in multiple languages on how consumers process and recall the provided information. Multilingual warnings may allow people to read the information in their preferred language, thereby potentially improving their recall (Miller and Keenan, 2011) or comprehension of the information (Malhotra et al., 2019). However, the resulting additional text may also create visual clutter and require additional time for details to be extracted, potentially reducing the efficiency of information processing (Jalal Eddine and Moacdieh, 2023; Jamson et al., 2005) or perceived processing fluency (Hüttl-Maack and Munz, 2025). While literature on how bilingual or multilingual warnings or safety information impacts consumer behavior is limited, researchers have examined how general product information provided in different languages may impact consumer behavior. For example, Hüttl-Maack and Munz (2025) examined how the number of foreign language translations of product information (e.g., product category, product information, tag line) and the familiarity of those languages influence subjective processing fluency of the information and subsequent attitude, perceived quality, and purchase intention towards the product. Their findings indicated that native German speakers did not report a decline in processing fluency when packaging contained up to four foreign language translations. However, when six languages were included, processing fluency decreased, contributing to lower product attitudes, perceived quality, and purchase intention. It should be noted that the specific combination and number of languages that appear on a label may play a role in shaping consumer responses. While Gopinath, Glassman, and Nyer (2013) did not directly examine processing fluency, they found that when packaging included a language associated with an outgroup for which the consumer held negative beliefs, product evaluations declined. Interestingly, the addition of a third language mitigated this effect (Gopinath, Glassman, and Nyer, 2013). Further research could help assess specific impacts of multilingual warnings on other aspects of information processing, such as attention during information processing and how different language combinations may impact these effects.

Whatever benefits or drawbacks multilingual safety information may have, the feasibility and reliability of providing such safety information can also be considered. While the availability of machine translation has become more widespread, machine translations can also struggle to accurately translate domain-specific technical language, may struggle to disambiguate ambiguous language, and may lack sufficient data on less common languages to produce accurate translations (Naveen and Trojovsky,

2024; Taira et al., 2021). According to Wang and Friginal (2025), in the field of aviation, the combination of frequent, necessary updates to technical documentation, the need for precise, technical equivalence across languages, and reliability concerns of existing machine translations means that translating safety information has been determined to be unsustainable and risky. In other industries, some companies have sought to overcome shortcomings of machine translation by developing their own specialized language, incorporating only terms with a narrow semantic scope (Kamprath et al., 1998). However, research on machine translation of such specialized languages remains limited. No existing research specific to the potential promise of artificial intelligence (AI) in translation of warnings and safety information was found in our review.

NON-LINGUISTIC COMMUNICATIONS

Non-linguistic warnings, such as pictograms, symbols, colors, and other types of visual or auditory stimuli can also play a role in communication of safety information. One advantage of non-linguistic warnings may be their potential to transcend language and literacy barriers (e.g., Houts et al., 2006), but their effectiveness may depend on both their design and the cultural context in which they are used. Research suggests potential for significant benefits, but also some significant barriers in terms of attention, information processing, and user compliance.

Some researchers have concluded that users generally prefer warnings that include symbols, rating them as more informative and predicting that they will increase their likelihood of noticing or recalling a warning (Kalsher et al., 2016; Sojourner and Wogalter, 1998; Houts et al., 2006). In addition, some researchers have suggested that pictorial warnings can convey danger more intuitively (e.g., a skull-and-crossbones communicates "deadly" without any text; Smith-Jackson and Wogalter, 2000; Lesch et al., 2009) and can promote appropriate caution. Although these predictions do not appear to be borne out in terms of actual warning compliance (Shaver et al., 2006), research has suggested that pictograms are generally recognized more quickly and from farther distances than equivalent text (Tijus et al., 2007). Non-linguistic warnings also have the potential to enhance information processing by multilingual audiences. Specifically, pictograms have the potential to convey basic hazard information without words to users with low literacy or users who don't speak the primary language (Jae and Viswanathan, 2012; Malhotra et al., 2019). For example, one study reported that adding simple pictorials to prescription labels improved older adults' understanding in Singapore (Malhotra et al., 2019). In this study, only 27% of non-English speaking users had any comprehension of English-only labels, but this number increased to 46% when pictograms were included with the English-only label (Malhotra et al., 2019). Interestingly, once bilingual text was added to the labels, the number of elderly users that had any comprehension of the labels was similar regardless of the presence of an associated pictogram (66% for bilingual text-only vs. 65% for bilingual text with pictograms; Malhotra et al., 2019). Research also suggests that young children can identify that

certain symbols communicate a warning or hazard (e.g., skull symbol; Lin et al., 2015). Studies further suggest that adding icons to warnings may improve information processing and memory. For example, Sojourner and Wogalter (1998) found that medication safety instructions presented with both text and pictorials were better recalled than text-only versions. The authors hypothesized that the combination of text and symbol may leverage dual coding in memory (Sojourner and Wogalter, 1998).

While there may be potential benefits to using non-linguistic warnings, there are limitations that may provide barriers to use of these warnings (e.g., Korpi and Ahonen-Raino, 2013). For example, research suggests that comprehension is higher for more concrete warnings (e.g., an image depicting a tractor rolling over) compared to more abstract warnings (e.g., a picture of a book; Bagagiolo et al., 2019; Vigoroso et al., 2020). As a result, abstract or complex instructions may be difficult to convey via pictograms (e.g., concepts such as delaying an action by a predetermined amount of time; Collins, 1982; Sojourner and Wogalter, 1998). Non-linguistic warnings that do not have accompanying text to clarify the intended message may need sufficient concreteness and clarity to reduce risk of confusion or misinterpretation (see, e.g., ANSI Z535.3-2022: Criteria for Safety Symbols). Research also suggests that comprehension of non-linguistic warnings increases with user experience and knowledge of the context of the warning (e.g., more years working in the agricultural industry when observing a warning on an agricultural product; Bagagiolo et al., 2019; familiarity with a medical concept; Zender and Cassedy, 2014). In adopting requirements for symbols on workplace chemical labeling, OSHA noted that adding pictograms to labels will not provide useful information unless efforts, such as training, are also undertaken to ensure that employees understand the meaning of the pictograms (OSHA, 2012, pp. 17588-17590).

Research also suggests that warning symbols commonly understood in some parts of the world may not be understood across all cultures. For example, Smith-Jackson and Essuman-Johnson (2002) presented Ghanaian workers with hazard symbols commonly used in U.S. warning labels. Aside from a "skull" symbol used to denote a poisonous/lethal hazard, other common warning symbols, such as an "electric shock" or the "asterisk" were poorly understood (e.g., Smith-Jackson and Essuman-Johnson 2002). Even the "prohibition" symbol (which typically means canceled, do not use, or do not enter) was only correctly identified by 58% of Ghanaian workers (Smith-Jackson and Essuman-Johnson, 2002). Differences in cultural associations may also affect the efficacy or comprehension of non-linguistic warnings in cross-cultural use (e.g., Bagagiolo et al., 2019; Vigoroso et al., 2020; Zender and Cassedy, 2014). For example, Bagagiolo et al. (2019) presented non-linguistic warnings conveying lethal and non-lethal risks from agricultural equipment to Indian, Pakistani, and Romanian farmworkers in Italy. The results indicated marked comprehension differences, with Romanian workers providing 68.8% correct interpretations, Indian workers providing 35.4% correct interpretations, and Pakistani workers providing 32.4% correct interpretations (Bagagiolo et al., 2019). Interestingly, Blees and Mak (2012) found that providing photographs containing additional context

(e.g., a photograph of a river along with a pictorial denoting a river crossing location) helped improve comprehension of the associated pictorial for cross-cultural audiences. Comprehension testing of symbols across multilingual audiences during the development of non-linguistic warnings (e.g., Wisniewski et al., 2007) may provide important feedback.

Finally, even if the meaning of hazard symbols is correctly understood, the perception of hazard severity may still vary across audiences. Lesch et al. (2009) found that American and Chinese users both understood hazard information from pictorial warnings (e.g., a skull-and-crossbones symbol), but American users generally perceived greater hazard from the pictorials compared to Chinese users. Similarly, while some research suggests that cues such as color can promote hazard understanding cross-culturally (i.e., RED-DANGER, YELLOW/ORANGE-CAUTION; Borade et al., 2008; Smith-Jackson and Wogalter, 2000; Gopang et al., 2024), research has also found that American users perceived a greater amount of hazard from red and yellow warnings compared to Chinese users, who perceived a greater amount of hazard from green warnings (Lesch et al., 2009).

Taken together, available research suggests that non-linguistic warnings may be helpful for communicating across language barriers. However, important barriers may include the concreteness of the warning symbol, the user's culture, and the user's experience. As such, a non-linguistic warning may work best when tailored to the audience's cultural context or developed with user testing among cross-cultural audiences.

CONCLUSION

In this review, we have highlighted three options that can be used to communicate warnings and safety information to multilingual audiences: (1) monolingual communications through a dominant local language, (2) multilingual or bilingual communications, and (3) non-linguistic communications. We have summarized available research and discussed some advantages, limitations, and practical considerations that may accompany each method. Future research could further clarify conditions in which consumers are more likely to comprehend warnings or safety information presented in a non-native language (e.g., language proficiency, industry experience) and when alternative communication methods—such STE, bilingual/multilingual communications, or non-linguistic communications—may be more effective. Additionally, future research could examine alternative, less explored communication methods, such as using online links to provide content in additional languages that may otherwise not be possible given space limitations, to the extent that these methods comply with local regulations (Isaacson et al., 2019). In sum, our review provides theoretical and practical considerations entities may consider when selecting a method to communicate to linguistically diverse audiences, based on available research, and highlights additional avenues for potential future research.

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