

# WHAT DOES CODE RED MEAN?

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The U.S. Department of Homeland Security developed the Homeland Security Advisory System (HSAS) as a means to disseminate information regarding the risk of terrorist acts. HSAS communicates a series of warnings in the form of five graduated threat conditions that utilize three distinct attributes: colors, words, and phrases. As the table below illustrates, each of these attributes is composed of five components that are ordered to communicate five distinct threat levels. The purpose of this additional study was to determine the effectiveness of HSAS as a means of public hazard communication by empirically assessing people's understanding of the system.

Our 57 participants (see page 7 in the accompanying article) were given a set of index card labels and asked to rank the colors, words, and phrases from most threatening to least threatening. During color label sorting, 57.9% of them erred by deviating from the correct order illustrated in the table below. When examining the specific errors made, we found that the most frequent errors occurred when participants thought the blue threat condition was less threatening than the green condition (78%). Another source of error resulted from participants confusing the orange with the yellow threat condition (12.1%). Together, these two categories of confusion account for more than 90% of the color-sorting errors.

The word-sorting task revealed somewhat better results: only 33.3% of the sample deviated from the correct order. Participants most frequently confused the guarded condition with the low condition (42.1%) and less frequently confused the elevated with the guarded condition (21.1%). Together, these two categories of confusion account for more than 63% of the errors during word sorting.

Participants were the most accurate when asked to order the descriptive phrases, compared with the other sorting tasks. In the phrase-sorting task, 26.3% deviated from the correct order. Participants most frequently confused "Significant risk of terrorist attacks" with "High risk of terrorist attacks" (26.7%) and less frequently confused "Severe risk of terrorist

attacks" with "High risk of terrorist attacks" (13.3%). Together, these categories of error accounted for 40% of the errors during phrase sorting.

The error-laden results of the three sorting tasks provide converging evidence that HSAS may not be an effective hazard communication tool. These results are not surprising when considered in the context of previous work within the human factors/ergonomics warnings literature (Laughery, Wogalter, & Young, 1994; Wogalter, Young, & Laughery, 2001). For instance, the results of the color-sorting task are consistent with previous research: Although the color red consistently connotes the presence of a hazard, orange and yellow are not readily differentiated on the hazard continuum (Chapanis, 1994). Colors such as red and yellow suggest greater levels of hazard than other common colors, such as green and blue, but research indicates that people do not perceive blue to be more hazardous than green (Braun & Silver, 1995; Rashid & Wogalter, 1997). Thus, participants' poor performance on the color-sorting task was predictable.

Had human factors/ergonomics professionals been consulted on the design of HSAS, the misunderstandings associated with color coding of threat levels might have been avoided, resulting in a more effective hazard communication tool. Similar confusions in the word- and phrase-sorting tasks might also have been avoided in light of extensive research demonstrating that people frequently have difficulty distinguishing one signal word from another, such as "danger," "warning," and "caution" (Braun, Kline, & Silver, 1995; Leonard, 1999). The designers of HSAS might have avoided the use of this attribute entirely.

At the very least, HSAS should have been tested prior to deployment to determine whether the public could distinguish among the five threat levels. Had this testing occurred and the findings reflected the confusion revealed in the present results, alternative attributes such as numbers (i.e., 1-5) or percentages (e.g., 80%) might have been explored as a means to disambiguate the threat levels.

The  
Homeland  
Security  
Advisory  
System



HSAS ATTRIBUTES AND ORGANIZATION OF COMPONENTS FROM MOST THREATENING (TOP) TO LEAST THREATENING (BOTTOM)

Colors	Words	Phrases
Red	Severe	Severe risk of terrorist attack
Orange	High	High risk of terrorist attack
Yellow	Elevated	Significant risk of terrorist attack
Blue	Guarded	General risk of terrorist attack
Green	Low	Low risk of terrorist attack

slowly. Representative comments included “show open slowly” and “use arrow differently to indicate slow.” Of the 24 design suggestions for the symbol meant to illustrate not yelling when trapped under debris, representative comments included “Nothing to indicate that yelling is the last resort” and “Number the action steps.” Because each of these symbols is meant to communicate a set of actions (i.e., multiple propositions) that should be initiated in sequence, the complexity of the message content exceeds what is acceptable for a single symbol (Dewar & Arthur, 1999). Moreover, message content is dependent on the abstract concept of time, which is not readily visualized; thus, the utility of using a pictorial symbol in these two instances is not recommended (Leonard et al., 1999).

The participants’ design recommendations, though insightful and accurate, would be very difficult to execute and may not result in better DHS symbols. Had DHS conducted some form of preliminary testing before these safety symbols were deployed for use by the public, they might have discovered that these are two instances in which pictorial symbols are not amenable for the job intended.

## One source of concern with the current DHS education framework is that it is available only on the Internet.

As Hancock and Hart (2002) recently illustrated, human factors/ergonomics professionals possess skills and expertise that can be applied in a number of technical areas, such as airport security and emergency response to advance counterterrorism efforts. Given the low comprehension rates and high percentage of critical confusions associated with the current DHS safety symbols, HF/E professionals might be of service in pictorial warning design and evaluation. They have at their disposal well-established, psychometrically validated methods that produce more effective hazard communication (see Wogalter, DeJoy, & Laughery, 1999, for a review). Here we describe how these methods might be used to improve the DHS pictorial safety symbols.

**Selection of concepts through precursor testing.** The process for developing effective pictorial warnings is often expensive, inefficient, and time-consuming (Wolff & Wogalter, 1993). Research shows that concept concreteness is positively correlated with how well people comprehend the meaning of pictorials (McDougall & Curry, 2000). Recent work by Hicks et al. (2003) indicated that precursor tests of concept concreteness and ease of visualization can be used to predict the likelihood of designing a successful pictorial warning symbol. Thus, preliminary testing of concepts should allow designers to identify instances in which abstract, nonconcrete concepts would result in incomprehensible symbols.

Because many of the DHS symbols were designed to convey information concerning abstract concepts, precursor testing might have identified cases when the likelihood of

developing an effective pictorial symbol was low. Not only would DHS have avoided wasting valuable time and money on the development of incomprehensible symbols meant to convey abstract message content, the agency also might have identified more concrete concepts to enable it to concentrate efforts on designing useful safety symbols.

**Iterative comprehension testing and rapid prototyping.** Once concrete concepts have been identified, prototype symbols should be developed and tested for comprehension with a sample of the at-risk population (as described in the current study). Symbols that do not meet acceptable levels of comprehension should be redesigned based on feedback from the earlier test participants and retested for comprehension in an iterative process (design, test, redesign, test, etc.) until a satisfactory level of comprehension is reached. Rapid prototyping is one method used to conduct iterative testing, whereby prototype warnings are continually redesigned and improved based on the evaluations of test participants (Wogalter, Vigilante, & Conzola, 1999).

**Training via an awareness campaign.** Although we have focused on the comprehension of pictorial warnings in this article, it is important to realize that the development of pictorial symbols is only one component of the DHS warning system. For the DHS public education framework to be successful, the public must first be aware of it. Of the 57 participants tested in our study, only one had previously encountered the DHS safety pictorials, but not on the official Web site. If people are to recognize and activate preexisting safety information when they encounter a pictorial symbol, initial training in the form of exposure to the material may be necessary to ensure that people first learn specific safety information. When they encounter pictorial symbols during real-world tasks, the symbols could then serve to cue access to previous knowledge, thereby guiding their behavior (Leonard et al., 1999).

Clearly, recognition and use of the DHS pictorial symbols requires that the public be informed that this information is available. This dependency on previous knowledge suggests that DHS should initiate a public awareness campaign that will inform the public where to access and become familiar with this information.

One source of concern with the current DHS education framework is that it is available only on the Internet. Although Internet access is growing, not everyone has direct access to DHS safety information. It might be useful if this information were made available through other media, such as paper copies at the local post office or television advertisements.

## ARE WE READY?

The Department of Homeland Security is faced with the Herculean task of preparing the public for future terrorist incidents. The DHS Web site asks, “Are we ready?” Based on the results of the symbol comprehension study described in this article, it appears that the answer is “Not yet.” Pictorial symbols cannot address every concept, and sometimes text

warnings are more appropriate. Knowledge of these limitations might have informed the design of the current symbols and resulted in the development of a more effective hazard communication system.

For something as important and serious as safety in times of national emergencies, unambiguous warnings are essential for safety promotion and injury prevention. With the active assistance of human factors/ergonomics professionals, DHS should come closer to accomplishing the strategic goals of fostering public education and preparedness, thereby depriving the terrorists of their most effective tools: disorder and fear.

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