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Effective Presentation Media for Passenger Safety I: Comprehension of Briefing Card Pictorials and Pictograms

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16. Abstract

Federal regulations require airlines to provide safety briefings and briefing cards to inform passengers of routine and emergency safety procedures onboard transport airplanes. The exact content and presentation media used for safety briefings and cards are the responsibility of the airlines to implement, as long as the required minimum safety information is delivered. Consequently, passenger safety briefings and briefing cards vary greatly, and passenger attention to such briefings has been poor at best. Studies have shown that typical passengers, even those who report that they pay attention to passenger safety briefings and briefing cards, have little personal knowledge and understanding of the information they have been given to improve their chances of survival. One strategy to increase safety knowledge among passengers is to improve the comprehensibility and appeal of safety briefings and briefing cards.

The present study was intended to address the current state of the art for airline safety briefing cards and was motivated, in part, by National Transportation Safety Board recommendations and research results demonstrating that passenger attention to safety information is waning. Pictorials and pictograms, selected from safety briefing cards currently used by airlines, and graphical symbols, approved by the American National Standards Institute (ANSI) and commonly found in buildings or other modes of transportation, were presented in open-ended-question format. The 785 participants were recruited from high schools, public and federal offices, cabin safety workshops at the FAA Civil Aerospace Medical Institute, and the SAE International Cabin Safety Provisions Committee, S-9.

Responses were categorized, based on correctness, and then transformed, using a weighting algorithm, to yield comprehension scores for each pictorial/pictogram. The scores ranged from 28.8% to 96.3%, with a mean comprehension of 65%. Only 45.8% of the scores exceeded the International Organization for Standards (67%) acceptance criterion, and only 8.3% exceeded the ANSI (85%) acceptance criterion. Comprehension scores for the ANSI symbols ranged from 40.5% to 97.6%, for an average "symbol literacy index" of 75%. Comprehension of pictorials/pictograms was related to the familiarity that cabin safety professionals and high flight-time passengers have with safety briefings and briefing cards.

Results indicate that safety briefing card pictorials/pictograms need to be designed and implemented with respect to novice passengers who do not have a prepotent understanding of the design and operation of transport aircraft, emergency equipment, and/or aircraft emergency procedures. Furthermore, textual clarifications to make safety information more meaningful could be expected to improve passenger attention to briefing cards.

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INTRODUCTION

Federal aviation regulations require airlines to provide safety briefings and briefing cards to inform passengers of routine and emergency safety procedures on board transport airplanes (e.g., 14 CFR 121.571, 125.327, 135.117). Federal Aviation Administration (FAA) Advisory Circular (AC) 121-24, *Passenger Safety Information Briefing and Briefing Cards* (U.S. Department of Transportation, 2003), and SAE Aerospace Recommended Practice (ARP) 1384*, Passenger Safety Information Cards* (2006), provide minimum safety content and presentation guidelines. The exact content and presentation media used for safety briefings and cards on board transport airplanes are the responsibility of the airlines to implement, as long as the minimum safety information required by the FAA is delivered. Safety information on briefing cards is typically presented graphically, using symbols, pictorials, and pictograms, although a limited number of cards employ minimal text, as well.

The development of graphical symbols and the history of pictorial comprehension testing began with searches by Brainard, Campbell, and Elkins (1961) for the *meaningfulness* of abstract symbols. They had subjects develop open-ended definitions for graphical symbols, as did King (1971), and Easterby and Zwaga (1976), among others. Using a similar method, Brainard et al., Griffith and Atkinson (1977), and Wiegand and Glumm (1979) had subjects select definitions for each symbol in a set from a long list of potential meanings. Brainard et al. also compared these two methods, using a single symbol set, finding that the less rigorous symbol-definition matching procedure achieved higher meaningfulness scores than those from the open-ended procedure. Green (1979) had subjects create a drawing of a symbol in response to being provided a meaning; the commonality of images produced by subjects allowed for insight regarding universality of symbol meaning. Additional comprehension testing techniques included having subjects rate the meaningfulness of symbols (Dewar & Ellis, 1977), estimate the magnitude of symbol meaningfulness (Green & Pew, 1978), and rank-order symbols for a given meaning (Easterby & Zwaga, 1976; Easterby & Hakiel, 1977). The latter method has been shown to be particularly good at establishing the relative comprehensibility of competing symbol candidates, especially with regard to safety symbols. A variety of stimulus materials (e.g., placards, slides, booklets) was used in these studies, although no direct comparison of presentation methods was made. Development of candidate safety symbols proceeded apace with these investigations, and the International Organization for Standardization (ISO; 1979) proposed 21 such symbols for fire safety information. Similarly, the American National Standards Institute (ANSI) formed the Z535 Committee on Safety Signs and Colors in 1979; its mission was to further develop and refine safety signs already being designed for implementation in the U.S. Only after significant research and testing of safety symbols, in particular, were testing standards for pictographic materials eventually codified in ISO 9186:1989, *Graphical Symbols - Test Methods for Judged Comprehensibility and for Comprehension.*

Using 20 of the original ISO symbols in an initial comprehension assessment in which 143 subjects participated, Collins and Pierman (1979) found that nine symbols were understood by fewer than 30% of their participants, although other symbols achieved 90% comprehension. The reasons for the discrepancy remained conjectural. Lerner and Collins (1980) conducted a second study of the ISO symbols after two of the more poorly understood symbols had been modified and three others were added to the set. The stimulus materials and methodology were selected to test not only the symbols but also to evaluate pictorial comprehension testing methods. Subjects were formed into groups, with each group receiving either placards, slides, or booklets, randomly presented. Regarding response type, half the subjects in each group provided definitions of the symbols, while the other half chose among multiple-choice definitions. Upon completion, all subjects were given definitions and asked to draw symbols to convey appropriate meaning. Using two analyses, based on *strict* and *lenient* scoring criteria for meaningfulness, the authors found no effect of stimulus presentation mode, nor any interaction with response type, for strict scoring. There were also no significant differences for response type using lenient scoring; however, symbol meaning scores were much higher for the groups who chose from multiple definitions. Lerner and Collins concluded that for future work, stimulus presentation mode was essentially a matter of convenience, although response type required more consideration. Open-ended responses provided the most variability and required the

most attention to scoring detail, especially with regard to *partially correct* definitions. The time and effort required to attain reliable results were large. In contrast, multiple choice responses were faster and easier to obtain, although the constraints on alternative answers and the ease of guessing the correct response "yielded generally higher estimates of meaningfulness for poorly understood stimuli." The authors suggested, when using the multiple choice methodology, the use of alternative responses, obtained first in open-ended pictorial comprehension testing, paired with confidence ratings for each multiple choice response. This technique could be used early in the pictorial design process to improve comprehensibility before more formal, open-ended comprehension testing began. They also concluded that certain drawings produced by the subjects in response to the definitions they were presented indicated that some image concepts are more difficult to portray pictorially, leading to a need for redesign of the pictorial or education of the user. A final concern was that the comprehension scores in their study were much higher than those of Collins and Pierman, for which the authors concluded that the earlier subject sample may not have been fully representative, reinforcing the need to employ subjects of varied demographic type. Their discriminative assessment of stimulus presentation mode, response type, scoring method, and research subject characteristics elevated the Lerner and Collins study to become the seminal strategy for comprehensive pictorial evaluation.

In developments related specifically to briefing card design, Dwyer (1967) showed that diagrams were superior to photographs for instructional materials, because "diagrams apparently require less study to distinguish important from insignificant details." Similarly, Wright (1971) found that flow charts could be superior to narrative text for delivering instructions and step-by-step directions toward a goal. Kysor (1978) developed a hybrid flow chart method in which short text instructions were integrated within diagrams and activity sequences coded by shape and boundaries, which focused the readers' attention toward completion of task performance. Johnson (1980) improved this technique by using a series of associated action pictures or pictorials, called *pictograms*, reporting that pictorials and pictograms have advantages over text, since they are language independent and generally require less space to present the same message. A common theme in these investigations was that both information transfer and retention were enhanced, relative to written instructions. In a review of the growing trend toward graphical instructional design, Coskuntuna and Mauro (1980) developed several "rules of thumb" for such materials, which included 1) avoid information overload, 2) use concrete information, 3) prioritize, and 4) focus on actions, not reasons. Attention to these principles became an almost universal approach for aviation safety briefing cards; however, the degree to which their application provides effective information transfer has long been an issue.

The National Transportation Safety Board (NTSB, 1985) conducted a Safety Study of passenger safety briefing methods titled, *Airline Passenger Safety Education: A Review of Methods Used to Present Safety Information*. The rationale for the study was "a long standing concern that some passengers onboard air carrier airplanes have contributed to their own injuries or deaths because they were not prepared to respond appropriately to emergencies." Their study showed that "safety cards vary greatly" in content and presentation methods, as well as accuracy of information presented. Some cards were found not to meet FAA minimums. The NTSB concluded that many safety card depictions were found to be confusing and ambiguous, and they provided three recommendations to improve safety briefing cards: 1) tests and minimum comprehension standards needed to be developed to assure proper passenger actions based on the safety information presented, 2) revised air carrier Operations Handbooks and Bulletins and FAA inspector training programs were needed to provide better guidance based on results of passenger comprehension testing, and 3) a revision to FAA AC 121-24 (U.S. DOT, 1977) was needed to include updated information on a variety of emergency procedures. Further, the NTSB called for greater standardization of safety briefing materials, to be based on "long-overdue" qualitative and quantitative research into the best content and manner of conveying safety information to passengers.

The 1985 NTSB Safety Study quickly spawned research efforts into briefing card materials and their effectiveness. Schmidt and Kysor (1987) addressed the instructional design characteristics of 33 safety briefing cards, finding that of the cards employed in their study, subjects preferred cards that were slightly larger, less wordy, more colorful, and more graphic than the other cards. They also found that cards having words integrated with diagrams, as well as those comprised of pictogram sequences, were ranked higher. Comprehension of 13 aviation safety pictograms was studied by Jentsch (1996), using an international (British, French, German, U.S.) sample of 150 university students to assess the "universality" of pictograms for safety information transfer. Jentsch used a 3-way scoring matrix: 1) complete and correct, 2) incomplete but safe, and 3) wrong or unsafe. The results showed remarkable (85%) general comprehension, across all subject groups, which met the success criterion of (ANSI) standard Z535.3 (1991), leading Jentsch to conclude that "conveying aviation safety information by pictorial means appears to

be largely effective." However, the comprehension scores included both the first and second response categories; thus, Jentsch further concluded that "while passengers may get the 'essence' of a particular pictogram, it is often difficult for them to recognize [comprehend] specific details." Silver and Perlotto (1997) conducted a follow-on study in the style of Jentsch, in which they tested comprehension rates of pictorials on an actual McDonnell Douglas Super 80 safety briefing card. This card had seven series of pictograms identified by brief headings written in English (e.g., oxygen, emergency/brace position, water evacuation), with the meaning of each pictorial within the pictograms being the question(s) of interest. Their subjects were 120 university undergraduates, almost all of whom had flown on an airliner; 61% reported having read a safety briefing card before. Subject responses were scored as correct or incorrect when compared with those of a single control judge (pilot with 30 years' experience). Silver and Perlotto reported that 21 of the 40 pictorials tested exceeded the ISO 7001 (1979) 67% correct comprehension criterion, but only 11 exceeded the ANSI 85% success criterion. Responses such as "fasten seat belts, no smoking in the lavatory, move handle in direction of arrow, open door, place head between legs, and use seat cushion as flotation device" were understood by subjects much more readily than "stow away tables, no smoking in aisles, exit in a sitting position, brace against seat in front of you, light will illuminate in water when inflation tab (actually incorrect) is pulled, and move away from the aircraft." The authors explored several possible causes for the differences in comprehension of specific pictorials in relation to card layout and number of ideas represented by each pictorial, as well as the differences in responses related to whether subjects had read safety cards on prior flights. They concluded that Jentsch was correct regarding difficulty with understanding specific pictorial details. Importantly, they also concluded that "even if a pictorial is found to be understood by 86% of those tested, which would be considered 'acceptable' by standard [ANSI] comprehension criteria, there are another 14% who do not understand the pictorial. . . . This is extremely crucial" in potentially life-threatening emergencies.

In contrast to these largely positive results, Caird, Wheat, McIntosh, and Dewar (1997) studied the comprehension of 36 pictorials used by airlines, employing 113 volunteer subjects, subsequent to evaluation of candidate safety card pictorials by a focus group. Briefing cards were selected on the basis of unique design, ability to affect comprehension, and adherence to widely suggested design guidelines. They used a scoring scheme in which 0 = incorrect, 1 = partially correct, and 2 = fully correct. None of their pictorials achieved the ANSI 85% comprehension level. In fact, only a third (12) of the pictorials met the ISO 67% comprehension criterion; 16 achieved a comprehension level of 50% or greater. Caird et al. noted that Jentsch's (1996) categorization of responses as "incomplete but safe" and "wrong or unsafe" implied predictable actions consonant with the degree of pictorial comprehension attained, although "actual passenger behavior based on airline safety pictorials was a fundamental unknown." Thus, they concluded that for pictorials "not understood under ideal circumstances… it is difficult to conceive that correct passenger actions would result without the intervention of flight attendants in emergency situations."

Fennell and Muir (1992) sought to address behavior in a test of four safety briefing cards as part of a larger study of passenger attitudes, safety awareness, and comprehension of safety briefings and cards. The briefing card types included simple diagrams, diagram symbols explained by words, diagrams with some procedures explained by words, or photographs with some procedures explained by words. Briefing card topics included seat belt operation, emergency brace positions, lifevest donning, and oxygen mask utilization. Three hundred volunteers were randomly assigned to one of four equal groups, one for each safety card. At the start of the test, the participants boarded, and were seated in, a transport airplane; they then listened to a preflight safety briefing that included seat belt operation, lifevest donning, and oxygen mask usage, before being instructed to read the safety cards. After completing both briefings, behavioral responses were obtained by having the subjects operate seat belts, adopt a brace position, and locate, remove, and don lifevests; subjects also completed a questionnaire regarding oxygen masks, lifevests, and operation of exits. Seat belt operation was almost universally correct, with only five of the subjects showing any difficulty adjusting or unfastening their belts, none of which was briefing card related. Neither were there differences in adoption of brace position based on briefing card. Interestingly, however, the most common brace position was evinced by one-third of the subjects, who placed both hands on the back of their heads, a position not illustrated on any test card. During the debriefing, subjects reported that the depictions of multiple brace positions on the card were confusing. Lifevest usage provided the largest challenge to subjects, 46% of whom had trouble locating and removing the lifevests from the packages, requiring a full minute, on average, to complete the donning process. Again, none of the difficulties was associated with briefing card type, although the group receiving the simple diagram briefing card had generally faster donning times. Notably, only the simple diagram briefing card showed how to don the lifevest while seated. Regarding questionnaire results, briefing card type did not predict knowledge

of oxygen mask information, although only 36% knew that a *tug* was required to start oxygen flow, whereas 26% thought flow was activated by normal breathing and 26% were unable to provide an answer. Forty-one percent of subjects rated their ability to operate the overwing exit as high, while only 22% could correctly describe the procedure. Similarly, while 46% reported an ability to open the floor level exit quickly, only 8% could correctly describe how to do so. No attempt was made to discover if these discrepancies resulted from a lack of knowledge or descriptive difficulty. Briefing card type also had no effect on responses about exit opening. In general, subject responses were better to questions about information presented in both the pre-flight briefing and on the briefing card, as the redundancy seemed to eliminate some of the apparent confusion attendant to briefing-card-only safety instructions.

Combined, these studies provide a brief glimpse into the variability of comprehension test methods and findings on briefing cards wrought by the 1985 NTSB recommendations. In the 2000 Safety Study, *Emergency Evacuation of Commercial Airplanes*, the NTSB recognized some of the research that had been done since its 1985 study and the positive revisions to FAA guidelines (e.g., AC 121-24A) that had resulted. However, they continued to advocate that passenger actions in emergencies and post-emergency survival situations are dependent in large part on the safety information provided, and that "many air carrier safety briefing cards do not clearly communicate safety information to passengers. Therefore, the Safety Board believes that FAA should require minimum comprehension testing for safety briefing cards."

In the interim, FAA has amended AC 121-24 twice (1999, 2003), and the SAE Cabin Safety Provisions Committee, S-9, has recently revised ARP-1384 (2006). However, content and procedures were the focus of these efforts. Similarly, airlines have adopted many changes to their safety briefing cards, often in response to accident or incident reports, cabin safety research findings, or the result of operational concerns identified in aviation safety databases such as the National Aeronautics and Space Administration (NASA) Aviation Safety Reporting System (ASRS). Many of the changes to briefing card design and content have been developed by in-house caucus among cabin safety training specialists, derived from cabin safety information presented in workshops such as those held by the Civil Aerospace Medical Institute (CAMI) and at industry conferences dedicated to improved cabin safety. Depending on the source, the efficacy of such changes remains unverified.

The present study was intended to address the current state of the art for airline safety briefing cards. It was motivated by the NTSB (2000) Safety Study recommendations, as well as research results demonstrating that passenger attention to safety information is waning (Johnson, 1979; Corbett & McLean, 2004 a, b). Further, many of the deficits in passenger knowledge of aviation safety information continue to prevail. The need for enhanced safety information transfer on board airliners was further highlighted by Cosper and McLean (2004), who found a serious deficiency in the general availability of cabin safety information in the public domain, reinforcing the importance of safety briefing cards on board airliners. A study by the Australian Transportation Safety Bureau (ATSB, 2006), using focus groups to evaluate nine contemporary safety briefing cards, found "results of this process suggested that great variation exists in the design and content" of the safety cards – a reiteration of conclusions in the 1985 NTSB Safety Study. In the ATSB study, effectiveness of the safety cards reportedly suffered from 1) excessive graphical clutter, 2) overly complex drawings, and 3) overly simplistic illustration, considered unrealistic or unclear. These deficiencies were sometimes amplified by a lack of textual information that further detracted from safety card effectiveness. Thus, it would seem that comprehension of safety briefing cards remains problematical.

The extent to which safety briefing cards enhance passenger action and survival in emergencies is directly related to the clarity and comprehension of the safety information provided; those qualities need to be addressed to assure that passengers are well served. Toward that end, evaluation of briefing card pictorials and pictograms currently in use in the U.S. was conducted to assess their comprehension by a wide range of individuals, as well as to provide direction for improvements to safety briefing cards and briefing card test methodologies.

METHOD

Participants

In the current study, 785 participants were recruited from a variety of sources, including high schools, public offices, federal offices, cabin safety workshops at CAMI, and the SAE Cabin Safety Provisions Committee, S-9. More than 90% spoke English as a first language.

Participant gender was fairly evenly split with 358 (46%) males and 427 (54%) females. Participant age ranged from 15 to 63 years and, except for the correlational analyses, has been categorized for analysis according to ISO 9186:2001 (Table 1). Education level ranged from students currently in high school to doctoral graduates (Table 2). Participants reported having taken from 0-2000 flights over the most recent two years, with the largest number of flights coming from active-duty flight attendants (Table 3). Participants' cabin safety expertise

Table 1

Subject Age Categories

Age	Frequency	Percent
15-30 years	566	72.1
31-50 years	167	21.3
51+ years	52	6.6
Total	**785**	**100.0**

Table 2

Subject Education Level Categories

Education	Frequency	Percent
High School Student	341	43.4
High School Diploma	234	29.8
Associate's Degree	94	12.0
Bachelor's Degree	90	11.5
Master's / Doctorate	26	3.3
Total	**785**	**100.0**

Table 3

Subject Commercial Flight History Categories

Number of Flights in Previous 2 years	Frequency	Percent
0-2 trips	366	46.6
3-6 trips	188	24.0
7-12 trips	81	10.3
13+ trips	150	19.1
Total	**785**	**100.0**

Table 4

Cabin Safety Expertise and Commercial Flight History

Expertise	Number of Flights in Previous 2 years	Frequency	Percent
Adult Expert	0-2 trips	3	1.9
	3-6 trips	20	12.7
	7-12 trips	16	10.2
	13+ trips	118	75.2
	Total	**157**	**100.0**
Adult Non-Expert	0-2 trips	86	53.1
	3-6 trips	39	24.0
	7-12 trips	22	13.6
	13+ trips	15	9.3
	Total	**162**	**100.0**
Student Non-Expert	0-2 trips	277	59.4
	3-6 trips	129	27.7
	7-12 trips	43	9.3
	13+ trips	17	3.6
	Total	**466**	**100.0**

was based on their educational/professional status, with aviation industry personnel being categorized as experts, when compared with non-industry adults and students. Cabin safety expertise and commercial flight history, both within and between subject expertise categories, may be seen in Table 4. Correlations among subject demographic variables are shown in Table 5, with significant correlations designated by asterisks.

Stimulus Materials

Forty-one pictorials and pictograms selected from safety briefing cards currently used by airlines, as well as seven ANSI Z535 graphical symbols present in other modes of transportation or buildings, were included in the study. (Airlines and safety briefing card designers will not be identified.) The ANSI symbols were included in support of a companion study of graphical exit signage, as well as to allow the development of a *symbol literacy index* intended to provide an estimate of participants' general *graphical IQ* (see Appendix A). Six sets of individual research booklets were created for the open-ended response and true-false/multiple-choice comprehension test. The booklets consisted of an informed consent page, written instructions, approximately 20 full-color pictorials/pictograms and ten symbols, one to a page, with one, two, or three questions about the meaning of the pictorial/pictogram/symbol and space to record written responses on each page (See Figure 1). The last page in each booklet contained a number of questions related to aircraft cabin safety. The order and selection of the pictographic elements was randomized for each set of booklets (see randomization of pictorial/pictogram categories for each test booklet order in Appendix B).

Procedure

Participants were given a research booklet in either an individual or group setting. The research facilitator directed participants to complete the consent form, review instructions, and then answered initial questions regarding the instructions. Upon the signal to start the test, participants turned to the first test page and began to answer the questions. After completing each response, each participant turned to the next page, without ever being allowed to return to a prior test booklet page, until all pictorials/pictograms/symbols and fill-in-the-blank questions in the test booklet had been addressed. The inability to return to a prior page was intended to preclude post hoc priming and correcting of a previously miscomprehended pictorial. The entire comprehension test required about 30 minutes to complete.

Data Collection/Analyses

Written responses to the pictorials/pictograms were reduced manually and entered into a Microsoft Excel® spreadsheet. The true/false and multiple-choice questions were scored only as percentage correct. The ANSI symbols were subjected to analysis by the Statistical Package for the Social Sciences (SPSS®) Text Analysis for Surveys 2.0 (2006) software package, followed by manual verification of the reliability achieved by this analytical technique. This proved to be a viable, efficient analytical approach allowed by the minimal variability and generally short

Table 5

Correlation Matrix for Subject Demographics

Demographic		Gender	Age	Education	Flights
Individual Age	*r*	.055			
	p	.122			
	N	785			
Education Level	*r*	.078*	.734**		
	p	.029	.000		
	N	785	785		
Number of flights	*r*	.029	.183**	.189**	
	p	.420	.000	.000	
	N	781	781	781	
Expertise Level	*r*	.061	.784**	.750**	.335**
	p	.090	.000	.000	.000
	N	785	785	785	781

(Pearson *r;* 2-tailed; *p* represents actual probability values; *p* * <.05 or ** <.01)

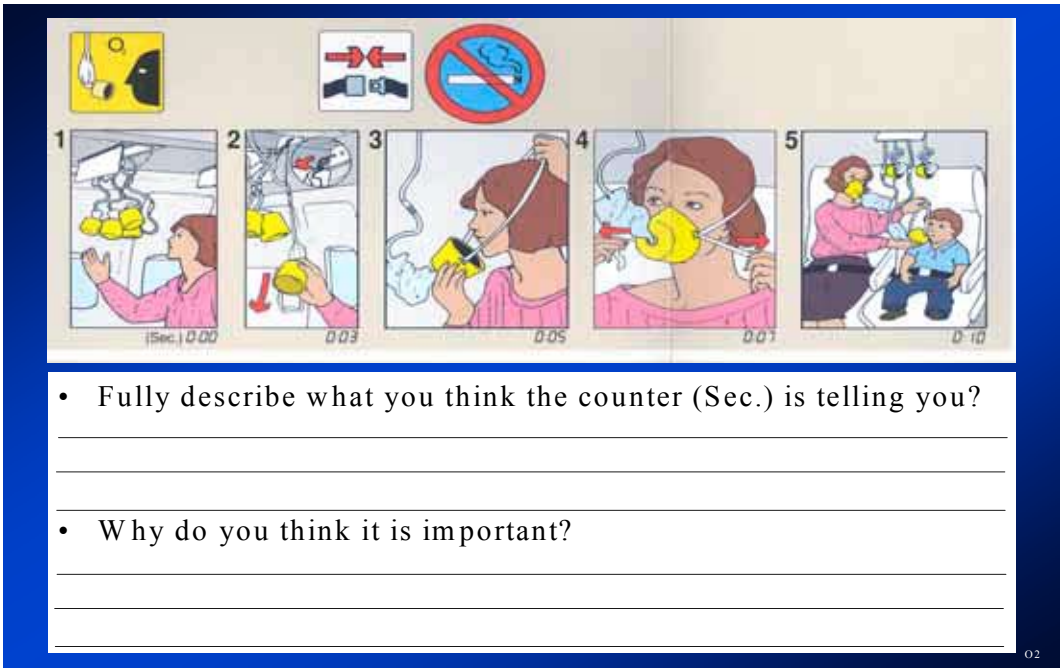

Figure 1. Sample test booklet page.

format of the responses received for each symbol. In contrast, the responses to the pictorials/pictograms were often lengthy, as well as highly variable linguistically, requiring manual scoring throughout. Therefore, a panel of five judges first established comprehension criteria for each pictorial/pictogram before evaluating the responses for correctness. Responses were first rated as to whether the subject had answered the specific question asked (Type 1 responses = specific question addressed, and Type 0 responses = specific question not addressed), followed by categorization of the responses for the correctness of the answer with respect to the comprehension criteria.

The comprehension estimate related to each pictographic element was based on the correctness of the responses to questions that had been addressed. These (Type 1) responses were categorized as follows: *certain* = response was correct and complete, *likely* = response was mostly correct but missing a key element(s), *arguable* = response contained words or ideas that indicated partial correctness but were ambiguous or unclear, *suspect* = response contained words or ideas that were related but misconstrued, *opposite* = response contained words or ideas that were related but contradictory to the correct response, *wrong* = response was wrong, *none* = response was "don't know," and *blank* = no response was given.

Categorized responses were then transformed, using a weighting algorithm, to yield pictorial/pictogram comprehension scores. Frequency of responses in each comprehension category was derived for each pictorial/pictogram. The frequencies for each comprehension category were then divided by the "n" number of subjects responding, except for blank responses, to get the percentage of total responses for each category. (Blank responses were not included in the scoring algorithm.) These percentages were multiplied by the comprehension category weights as follows: certain x 1.0, likely x 0.75, arguable x 0.50, suspect x 0.25, opposite x -1.0, wrong and none x 0.0, and summed to obtain the pictorial/pictogram comprehension score, i.e., the percentage of total comprehension for any particular pictorial/pictogram (see Figure 2). This method is essentially a recapitulation of the ISO 9186 (2001) comprehension test methodology, except that the current analytical convention contained four levels of positive comprehension instead of the three specified in ISO 9186, and the weightings for the comprehension categories were adjusted to account for this modification. This change in scoring methodology was made to provide better characterization of responses that were mostly correct but had a key element(s) missing, as well as responses that were poorly structured linguistically, but which addressed the pictorial/pictogram to some degree. In the many cases for which two or three questions were asked to enhance the estimate of comprehension, a composite categorization (score) reflected the comprehension revealed by the interaction of the individual answers, not merely that produced by their averaged comprehension estimates.

Response Type	Comprehension Category	Frequency	Percent	Weight	Comprehension Score
1	Certain	58	43.28	1.00	43.28
	Likely	6	4.48	0.75	3.36
	Arguable	21	15.67	0.50	7.84
	Suspect	35	26.12	0.25	6.53
	Wrong	8	5.97	0.00	0.00
	None	6	4.48	0.00	0.00
	Blank	1	-	-	0.00
	Total	**135**	**100**		**61.0%**

Figure 2. Categorized response frequencies transformed to yield comprehension score.

Many of the specific-question-not-addressed (Type 0) responses, especially for pictorials embedded within a larger pictogram, were related to more general themes in the overall pictogram. This indicated that subjects were not necessarily unaware of the correct answer; they may have just focused on something other than what the question had sought to determine. These responses were segregated and categorized only according to correctness and apparent understanding of the information they did provide, and form the basis for comparisons between the comprehension of "specific details" and pictographic "essence," after Jentsch (1996) and Silver and Perlotto (1997).

Pictorial/pictogram comprehension scores were further analyzed with respect to subject demographics, particularly gender, flight history, and cabin safety procedures knowledge and experience. All statistical analyses were conducted using SPSS® 15.0 (2006).

RESULTS

Comprehension data and individual results are provided in Appendix C for 15 of the 41 pictorials/pictograms tested in the study. (The remaining pictorials/pictograms will be analyzed and presented in a subsequent report.) The associated test booklet page is displayed, each pictorial/pictogram is identified by category and sequence number, and the comprehension criterion for each related test question is stated. This is followed by tables showing categories of responses and comprehension scores, as well as short summaries of specific results. The use of six different test booklets having different randomized sequences of pictorials/pictograms yielded differences in the exact number of responses for each.

A matrix of the comprehension scores is displayed in Table 6. Comprehension scores based on the individual question(s) for each pictorial/pictogram ranged from 28.8% to 96.3%, with a mean comprehension of 65.0%. These scores were derived from Type 1 responses only, i.e., those responses directed to the specific question(s) that was asked. Composite comprehension scores were also derived from the Type 1 responses; however, these scores were related to the comprehension evidenced by a *combination* of the responses to individual questions about the particular pictorial/pictogram. The composite scores ranged from 39.8% to 85.3%, with a mean of 64.7%. A final "overall" comprehension score was derived for pictorials/pictograms, which included Type 0 responses that indicated some degree of general understanding but did not address the specific question(s) that had been asked. The Type 0 responses for each case were categorized as the Type 1 responses had been, and a weighted average of the composite and Type 0 comprehension scores was computed to obtain the overall comprehension scores, which ranged from 38.8% to 85.3% with a mean of 64.7%.

To provide further characterization of the comprehension scores with respect to individual subject differences, subject demographics were used to discriminate among alternate explanations for the effects seen. As can be seen in Table 5, both age and education level were significantly correlated with flight history and cabin safety expertise and were not included in further analysis. Although flight history and cabin safety expertise were also significantly correlated, these demographic variables were used to assess the influence of cabin safety knowledge and experience on safety briefing card comprehension. These associations and their significance are also presented in Appendix C. There were no gender differences for any of the briefing card comprehension scores.

A symbol literacy index derived from subject responses to the seven ANSI standard symbols had been intended to provide better understanding of response and comprehension differences. However, individual symbol literacy averaged 75%, without differences among or within any subject subgroups, even though the four most common

Table 6
Comprehension Scores

Pictographic Element	Sequence Number	Individual Question Scores	Composite Scores	Pictogram Overall Score
1. Oxygen Equipment Usage	O1	56.0 / - / -	-	56.0
2. No Smoking in Lavatory	L3	81.0 / - / -	-	81.0
3. Seat Belt Usage	B1	85.1 / - / -	85.3	85.3
4. Seat Belt Usage	T1	78.5 / - / -	81.3	81.3
5. Overhead Bin Safety	OB1	73.7 / - / -	73.9	73.9
6. Warning	W1	37.1 / - / -	39.8	38.8
7. Emergency Exits	FLEX2	57.7 / - / -	60.0	58.5
8. Water Evacuation	WE3	56.6 / 75.6 / -	66.5	66.5
9. Flotation Device Usage	FDC1	45.6 / 57.3 / -	47.4	47.4
10. No Smoking in Lavatory	L4	96.3 / 61.0 / -	74.6	74.6
11. Brace Position	BP3	76.8 / 60.3 / -	68.6	68.6
12. Emergency Exits	OWEX1	71.8 / 68.4 / -	59.0	58.9
13. Floor Marking of Exit	FL2	82.8 / 68.5 / -	71.3	70.2
14. Oxygen Equipment Usage	O2	65.2 / 59.3 / -	63.8	59.7
15. Flotation Device Usage	FD2	54.5 / 62.1 / 28.8	49.4	49.1
Mean		**65.0%**	**64.7%**	**64.7%**

ANSI symbols achieved comprehension scores above 90% (see Appendix A). Thus, while general symbol literacy was greater than the ISO 9186 (2001) standard minimum of 67%, it fell below the 85% success criterion anticipated by ANSI Z535 (2002).

DISCUSSION

The results of this study recapitulate the findings by the NTSB (1985, 2000) and the ATSB (2006), as well as the larger research literature on safety briefing card comprehension. Whether 1) gauging comprehension via specific responses to questions about individual pictorials, 2) combining multiple responses to individual pictorials or combining responses to multiple pictorials within pictograms to assess composite understanding, or 3) pooling question-specific and general responses to gain an estimate of overall understanding, mean comprehension scores were below the standard success criterion in both ISO 9186 (2001) and ANSI Z535 (2002). Further, only 45.8% of the individual question comprehension scores exceeded the ISO standard (67%), and only 8.3% exceeded ANSI criteria (85%). Similarly, the pictorial/pictogram comprehension scores were below the mean 75% comprehension of the ANSI symbols tested. In sum, comprehension was well below acceptable limits.

The test booklet questions were generally of the open-ended variety and received a wide range of responses, especially for pictorials that contained multiple elements and/or multiple actions. The variety of responses was also greater for pictograms in which serial actions were not tightly linked pictorially. Participants also missed specific details in certain pictorials, especially when the details were not the main focus of the intended message. Often such details would only be identified by those who were thoroughly familiar with the activity being depicted. (Recall that the four ANSI symbols people encounter almost daily had over 90% comprehension.) This constellation of effects reinforces the conclusion that comprehension of briefing card pictorials and pictograms is related to familiarity of the referent(s) to which the pictorials/pictograms apply.

The demographics of the 785 participants in the study were widely diverse with regard to age, education level, commercial flight history, and cabin safety expertise; thus, participants formed a broad-based assessment tool for determining comprehension vis-à-vis familiarity of the pictorials and pictograms. The large correlations among demographic variables were produced by the progressive expertise associated with advancing age, education, and number of flights taken within the preceding two years; however, it was the inclusion of cabin safety professionals in the subject sample that allowed instructive, discriminative comparisons based on flight history and cabin safety expertise. Chi-square analyses on five of the pictorials, i.e., no smoking in lavatory, seat belt usage (2), emergency exits, and oxygen equipment usage, found no discriminative association of flight history and cabin safety expertise; importantly, no smoking signs and seat belt usage are common activities in everyday life, and

both emergency exits and oxygen equipment usage are verbally briefed before every flight. Chi-square analyses for the remaining ten pictorials (66.7% of the total) reflected a significant discriminative association of cabin safety expertise with comprehension, with flight history providing added explanatory power for seven of those ten pictorials. These effects were particularly evident for the pictorials/pictograms with lower comprehension scores, i.e., pictorials that were less well understood overall. Combined, these results indicate that comprehension of these pictorials/pictograms is, indeed, tied to the familiarity that cabin safety professionals and high-flight-time passengers have with safety briefings and briefing cards. Thus, the results indicate that safety briefing card pictorials/pictograms need to be designed and implemented with respect to novice passengers, i.e., those who do not have a prepotent understanding of the design and operation of transport aircraft, emergency equipment, and/or aircraft emergency procedures.

Production of briefing card materials would benefit from application of well-known educational principles and instructional techniques from outside aviation, whether produced by professional graphics designers or in-house airline cabin safety professionals. However, care must be taken to assure that individuals who form an *expert system* with regard to cabin safety information are aware that others do not *see* the same *pictographic vision* they intend to instantiate. The finding by ATSB (2006) of excessive graphical clutter, overly complex drawings, and overly simplistic illustrations considered unrealistic or unclear suggests a reliance on briefing card designers who know the information so well that their attention naturally focuses on the elements that best portray the message and disregards information or structure that detracts. Failure to test the comprehension of briefing card materials adequately obscures such shortcomings.

The comprehension test methods reported herein were designed to elicit the largest amount of information possible, necessarily without regard to the effort required for scoring. In addition to simply obtaining comprehension scores, a primary goal was to investigate the cognitive aspects of the responses. Multiple scoring algorithms were applied to almost all pictorials/pictograms presented, except for the two pictorials (one true/false and one multiple choice), which received limited responses based only on the choices available. For these two questions, there was no ability to probe participants' thinking, leading to a simple comprehension score based on test question format and content. In contrast, the open-ended responses allowed for deeper insight regarding participants' understanding and showed clearly why open-ended tests are considered the *gold standard* of cognitive comprehension testing. Comparison of scores across the question-specific, composite, and overall comprehension scoring algorithms found that neither method was superior to the others, suggesting that use of any of the scoring algorithms for open-ended questions would be acceptable. Use of the true/false or multiple choice testing approach would be susceptible to the *expert system* confounds, described above, and would be much less dependable with respect to assuring proper passenger safety education. For any of these methods, however, the adjunctive use of behavioral comprehension testing would provide the ultimate guarantee.

Additional safety briefing card elements that could assist in the passenger education process would include some amount of textual information to focus attention, highlight concepts, and simplify complex pictorials/pictograms. Such clarifications to make the safety information more meaningful could be expected to improve the poor passenger attention to briefing cards prevalent throughout commercial aviation (Corbett & McLean, 2004a) and enhance the personal knowledge and understanding of typical passengers. Standardization of validated safety briefing card information and presentation methods across the airline industry would provide not only a well-founded, consistent safety message, but also a degree of familiarity and, therefore, comprehension never before seen. Finally, adequate conveyance of safety information to passengers will avoid delays and difficulties that could result in injuries and fatalities when emergencies occur.

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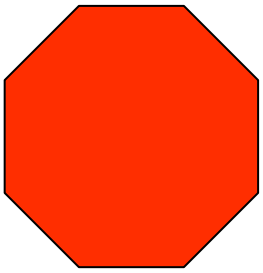
APPENDIX A

ANSI Symbols Used to Derive Symbol Literacy Score

STDS1

STDS2



STDS3

STDS4

STDS5

STDS6

STDS7

Table A-1
Comprehension Scores for ANSI Symbols

Pictographic Element	Sequence Number	Comprehension Score
Restrooms for men and women	STDS1	93.0
Fire extinguisher	STDS2	97.6
Stop	STDS3	95.2
No entry for vehicle	STDS4	40.5
Biohazard	STDS5	58.7
Safety alert	STDS6	54.3
Prohibited	STDS7	91.8
	Mean	**75.9%**

APPENDIX B

Table B-1
Comprehension Test Booklet Pictorial and Symbol Categories

Symbol	Category	Number Sequence
STDS	ANSI Standard Symbols	STDS1 – STDS7
O	Oxygen Equipment Usage	O1 – O3
WE	Water Evacuation	WE1 – WE4
FLEX	Emergency Exits (Floor Level)	FLEX1 – FLEX6
OWEX	Emergency Exits (Over Wing)	OWEX1 – OWEX6
BP	Brace Position	BP1 – BP4
FD	Flotation Device	FD1 – FD3, FDC1
OB	Overhead Bins	OB1
TLS	Take off – Landing – Surface Movement	TLS1 – TLS3
L	No Smoking in Lavatory	L1 – L4
B	Seatbelts	B1
T	Turbulence	T1
FL	Floor Lighting	FL1 – FL2
W	Warning	W1 – W2
GRMN	Exit Symbol without Context	GRMN1 – GRMN4
GRMN	Exit Symbol in Context	GRMN2C, 3C, 5C, 6C

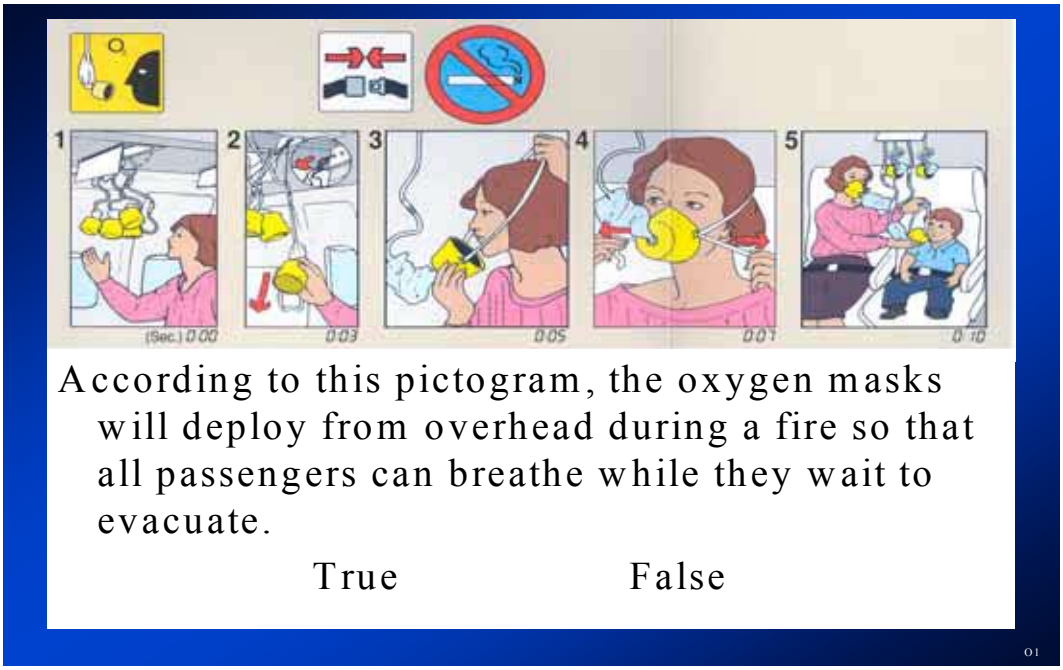
Table B-2
Randomized Test Booklet Contents

Booklet A	Booklet B	Booklet C	Booklet D	Booklet E	Booklet F
STDS1	STDS7	GRMN3/5C	GRMN1	STDS1	O3
WE2	FLEX5	STDS1	T1	OB1	STDS6
STDS6	STDS4	FD2	02	STDS2	FD3
BP1	OWEX4	STDS2	STDS1	O1	STDS3
B1	STDS1	OWEX6	BP1	STDS4	FLEX2
GRMN1	GRMN2/2C	STDS3	STDS4	FLEX1	STDS5
STDS5	W2	BP2	W2	STDS5	OWEX3
FL2	STDS5	L4	STDS3	FL2	STDS2
STDS3	O2	STDS4	WE4	STDS6	BP3
FLEX4	STDS6	TLS1	STDS5	FD1	STDS4
GRMN3/2C	TLS2	STDS5	OWEX1	OWEX2	GRMN3
O1	WE1	FLEX6	FD3	BP2	B1
STDS4	STDS3	STDS7	STDS2	STDS3	STDS1
OWEX5	FD1	WE3	FL1	GRMN1/3C	W1
STDS2	L2	STDS6	STDS6	GRMN2	GRMN2/5C
FDC1	GRMN3	O3	GRMN2/2C	STDS7	L3
STDS7	STDS2	GRMN1	L1	L2	STDS7
FD2	T1	FL1	STDS7	TLS3	FL1
T1	BP4	FDC1	FLEX3	W1	TLS1
GRMN4/6C	GRMN4/6C	GRMN4/6C	GRMN4/6C	GRMN4/6C	GRMN4/6C

APPENDIX C

Individual Pictorial / Pictogram Results

1.



Oxygen Equipment Usage (O1)

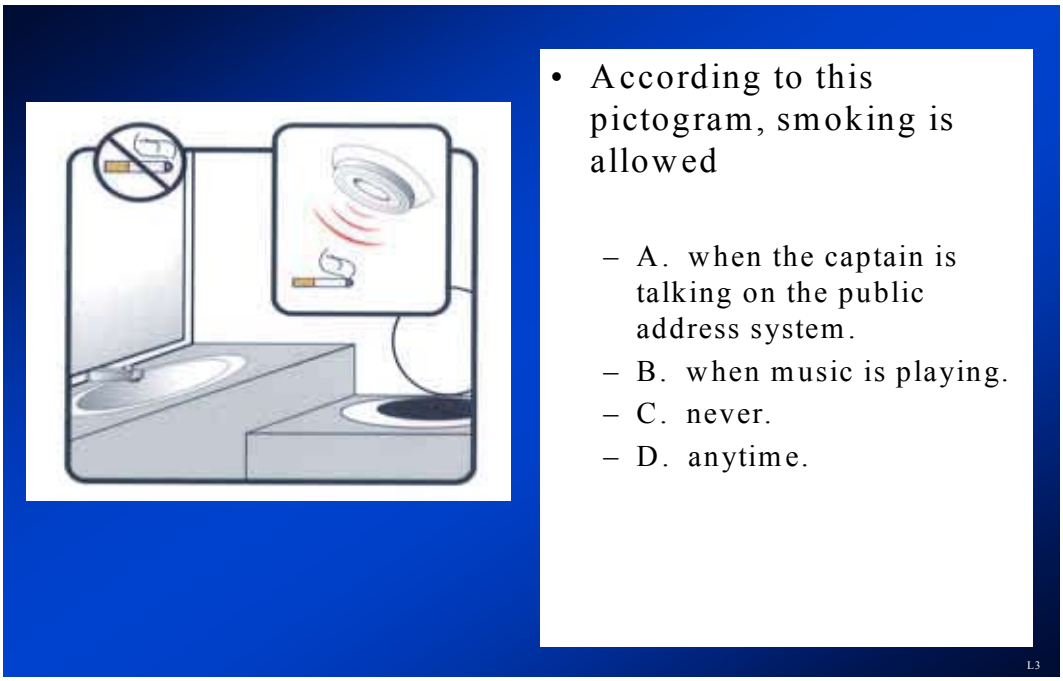
Comprehension criterion: False.

Oxygen Equipment Usage (O1) Question Score
(True / False)

Comprehension Category	Frequency	Percent	Weight	Comprehension Score
Certain	149	56.00	1.00	56.00
Wrong	117	44.00	0.00	0.00
Total	**266**	**100**		**56%**

All 266 subjects who received this oxygen equipment usage pictorial responded. Chi-square analysis revealed a positive association of cabin safety expertise [χ^2 (2, N = 266) = 61.19, p<.01] and number of flights [χ^2 (3, N = 265) = 46.16, p<.01] with comprehension. Without the responses from Cabin Safety experts, the comprehension score fell to 45.6%.

2.



No Smoking in Lavatory (L3)

Comprehension criterion: Multiple answer choice "C" was correct.

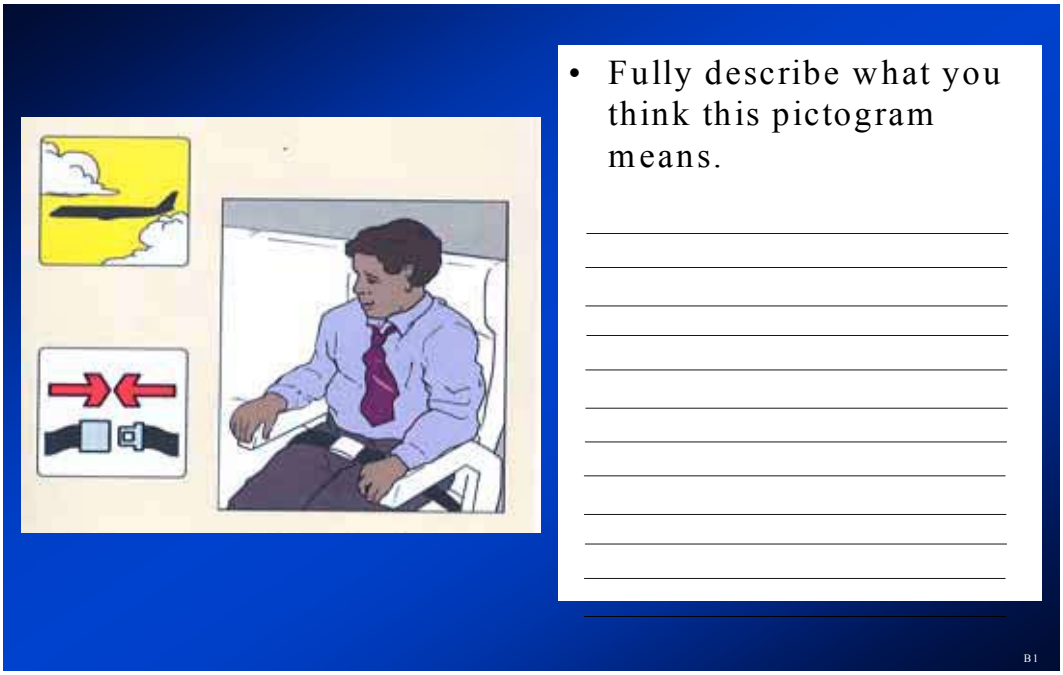
No Smoking in Lavatory (L3) Question Score (Multiple Choice)

Comprehension Category	Frequency	Percent	Weight	Comprehension Score
Certain	98	81.00	1.00	81.00
Wrong	23	19.00	0.00	0.00
Blank	1	-	-	0.00
Total	**122**	**100**		**81%**

Usable analytical n (121) does not include "blank" responses.

Chi-square analysis revealed that comprehension was not differentially associated with cabin safety expertise or flight history.

3.



Seat Belt Usage (B1)

Comprehension criterion: Keep seat belt fastened at all times during flight.

Seat Belt Usage (B1) Question Score

Response Type	Comprehension Category	Frequency	Percent	Weight	Comprehension Score
1	Certain	159	62.84	1.00	62.84
	Likely	66	26.08	0.75	19.56
	Arguable	11	4.35	0.50	2.18
	Suspect	14	5.53	0.25	1.38
	Opposite	2	0.79	-1.00	-0.79
	Wrong	1	0.40	0.00	0.00
	Blank	2	-	-	0.00
	Total	**255**	**100**		**85.1%**

Usable analytical n (253) does not include "blank" responses.

Of the 257 subjects who received this seat belt usage pictorial, 253 (98.4%) subjects answered the specific question asked, and two failed to respond at all. Chi-square analysis revealed that comprehension was not differentially associated with cabin safety expertise or flight history.

Comprehension Category	Typical Type 1 Responses
Certain	While in flight and while seated please ensure your seatbelt is fastened at all times.
Likely	Prepare for turbulence.
Arguable	How you should properly sit on a plane.
Suspect	Safety seat belt.
Opposite	You can unfasten your seatbelt at cruise altitude.
Wrong	Altitude sickness.

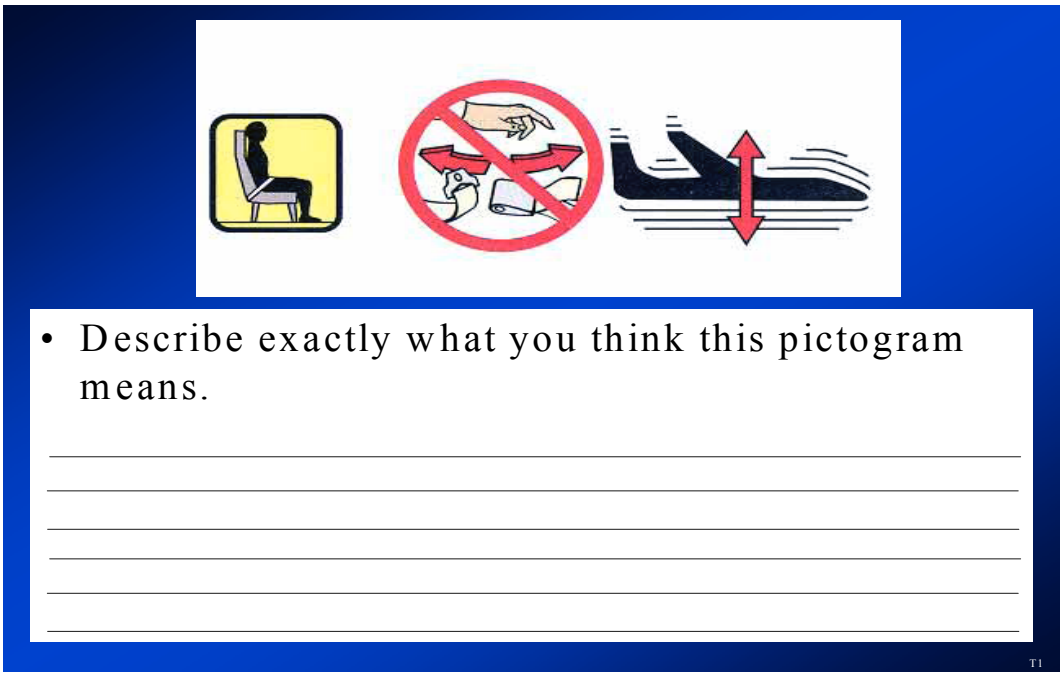
Seat Belt Usage (B1) Composite Score

Response Type	Comprehension Category	Frequency	Percent	Weight	Comprehension Score
1	Certain	160	63.24	1.00	63.24
	Likely	66	26.08	0.75	19.56
	Arguable	10	3.95	0.50	1.98
	Suspect	14	5.53	0.25	1.38
	Opposite	2	0.79	-1.00	-0.79
	Wrong	1	0.40	0.00	0.00
	Blank	2	-	-	0.00
	Total	**255**	**100**		**85.3%**

Usable analytical n (253) does not include “blank” responses.

The lack of any Type 0 responses yields an identical overall comprehension score.

4.



Seat Belt Usage in Turbulence (T1)

Comprehension criterion: Do not unfasten your seat belt during turbulence.

Seat Belt Usage in Turbulence (T1) Question Score

Response Type	Comprehension Category	Frequency	Percent	Weight	Comprehension Score
1	Certain	228	58.46	1.00	58.46
	Likely	60	15.38	0.75	11.54
	Arguable	53	13.59	0.50	6.80
	Suspect	38	9.74	0.25	2.44
	Opposite	3	0.77	-1.00	-0.77
	Wrong	5	1.28	0.00	0.00
	None	3	0.77	0.00	0.00
	Blank	7	-	-	0.00
	Total	**397**	**100**		**78.5%**

Usable analytical n (390) does not include "blank" responses.

Of the 397 subjects who received this seat belt usage in turbulence pictogram, 390 (98.2%) subjects answered the specific question asked about the pictorial, and seven subjects failed to respond at all. Chi-square analysis revealed that comprehension was not differentially associated with cabin safety expertise or flight history.

Comprehension Category	Typical Type 1 Responses
Certain	Seatbelts should remain fastened while seated in the event of turbulence.
Likely	Do not unbuckle when plane is in the air.
Arguable	Sit and buckle up the correct way.
Suspect	To buckle or unbuckle lift up or down.
Opposite	It is safe to unbuckle.
Wrong	Open your seatbelt when aircraft is on the water.

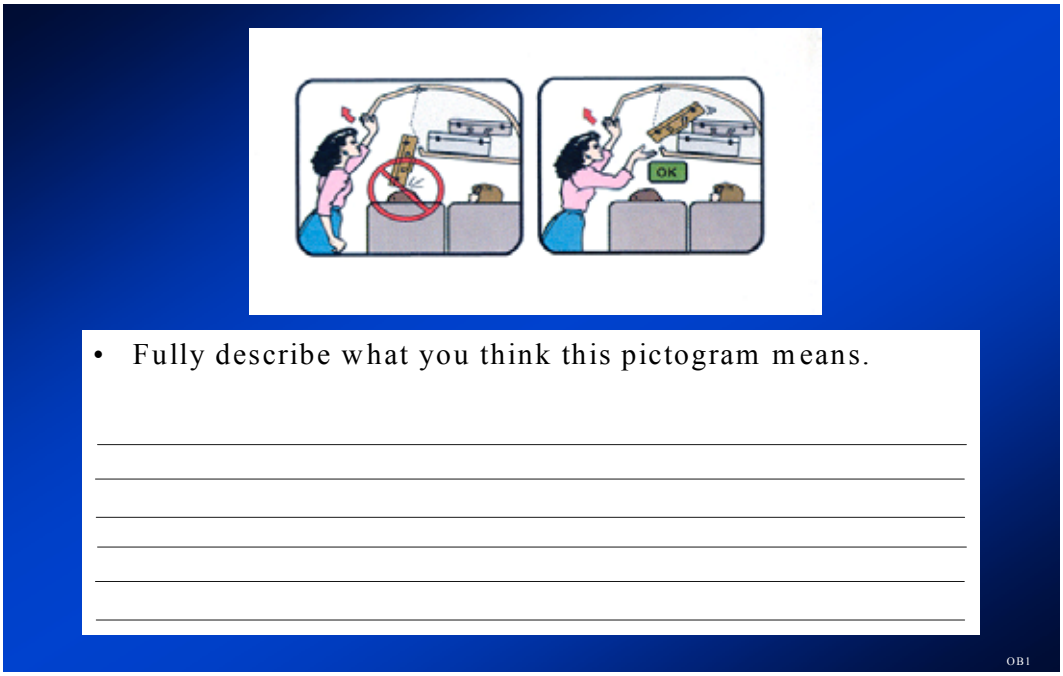
Seat Belt Usage in Turbulence (T1) Composite Score

Response Type	Comprehension Category	Frequency	Percent	Weight	Comprehension Score
1	Certain	230	58.97	1.00	58.97
	Likely	85	21.79	0.75	16.34
	Arguable	42	10.77	0.50	5.39
	Suspect	22	5.64	0.25	1.41
	Opposite	3	0.77	-1.00	-0.77
	Wrong	5	1.28	0.00	0.00
	None	3	0.77	0.00	0.00
	Blank	7	-	-	0.00
	Total	**397**	**100**		**81.3%**

Usable analytical n (390) does not include “blank” responses.

The lack of any Type 0 responses yields an identical overall comprehension score.

5.



Overhead Bin Safety (OB1)

Comprehension criterion: Be prepared to catch falling items when opening the overhead bin.

Overhead Bin Safety (OB1) Question Score

Response Type	Comprehension Category	Frequency	Percent	Weight	Comprehension Score
1	Certain	66	50.38	1.00	50.38
	Likely	27	20.61	0.75	15.46
	Arguable	15	11.45	0.50	5.73
	Suspect	19	14.50	0.25	3.62
	Opposite	2	1.53	-1.00	-1.53
	Wrong	2	1.53	0.00	0.00
	Blank	1	-	-	0.00
	Total	**132**	**100**		**73.7%***

Usable analytical n (131) does not include "blank" responses.

* Of the 132 subjects who received this overhead bin safety pictogram, 131 (99.2%) subjects answered the specific question asked about the pictorial, and one subject failed to respond at all. Chi-square analysis revealed an association of cabin safety expertise [χ^2 (12, N = 132) = 22.33, p = .04] with comprehension.

Comprehension Category	Typical Type 1 Responses
Certain	Be careful when opening overhead compartments. Make sure that your items don't fall out and injure passengers.
Likely	Be careful opening bin.
Arguable	Push your bag completely into the bin so it doesn't fall out when the door is opened to hit someone.
Suspect	Something about luggage falling.
Opposite	Exactly how to put the suitcase up.
Wrong	Ask the person below where you want to put your bag if it's okay or if it will fit.

Overhead Bin Safety (OB1) Composite Score

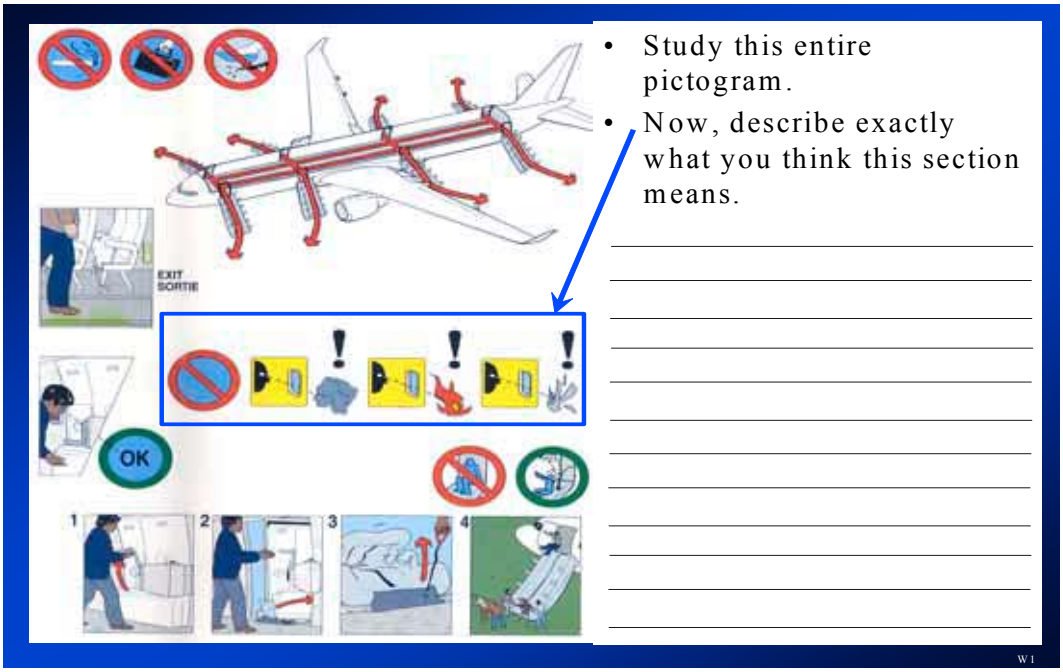
Response Type	Comprehension Category	Frequency	Percent	Weight	Comprehension Score
1	Certain	66	50.38	1.00	50.38
	Likely	27	20.61	0.75	15.46
	Arguable	16	12.21	0.50	6.11
	Suspect	18	13.74	0.25	3.44
	Opposite	2	1.53	-1.00	-1.53
	Wrong	2	1.53	0.00	0.00
	Blank	1	-	-	0.00
	Total	**132**	**100**		**73.9%***

Usable analytical n (131) does not include "blank" responses.

* Of the 132 subjects who received this overhead bin safety pictogram, 131 (99.2%) subjects answered the specific question asked about the pictorial, and one subject failed to respond at all. Chi-square analysis revealed an association of cabin safety expertise [χ^2 (12, N = 132) = 22.26, p = .04] with comprehension. Without the responses from Cabin Safety experts, the composite comprehension score fell to 71.3%.

The lack of any Type 0 responses yields an identical overall comprehension score.

6.



Warning (W1)

Comprehension criterion: Warning! Look out the window and do not open the door or exit if you see smoke, fire, or dangerous debris.

Warning (W1) Question Score

Response Type	Comprehension Category	Frequency	Percent	Weight	Comprehension Score
1	Certain	52	25.49	1.00	25.49
	Likely	37	18.14	0.75	13.60
	Arguable	25	12.25	0.50	6.13
	Suspect	26	12.75	0.25	3.19
	Opposite	23	11.27	-1.00	-11.27
	Wrong	26	12.75	0.00	0.00
	None	15	7.35	0.00	0.00
	Blank	8	-	-	0.00
	Total	**212**	**100**		**37.1%***

Usable analytical n (204) does not include "blank" responses.

* Of the 253 subjects who received this warning pictogram, only 204 (80.6%) answered the specific question asked about the pictorial, whereas 41 subjects (16.2%) responded with general information about other elements of the pictogram, and eight subjects failed to respond at all. Chi-square analysis revealed an association of cabin safety expertise [χ^2 (14, N=212) = 73.87, p < .01] and flight history [χ^2 (21, N=212) = 54.01, p < .01] with comprehension.

Comprehension Category	Typical Type 1 Responses
Certain	If you look outside an exit and you see smoke, fire, or debris, do not use the exit.
Likely	Check out the windows at all times to make sure you don't exit to something bad.
Arguable	Watch for smoke, fire, and glass.
Suspect	Telling you what to do in case of fire.
Opposite	Don't look to see smoke, fire, or broken glass.
Wrong	Break glass if fire occurs.

Warning (W1) Type 1 Composite Score

Response Type	Comprehension Category	Frequency	Percent	Weight	Comprehension Score
1	Certain	52	25.37	1.00	25.37
	Likely	41	20.00	0.75	15.00
	Arguable	27	13.17	0.50	6.59
	Suspect	25	12.20	0.25	3.05
	Opposite	21	10.24	-1.00	-10.24
	Wrong	23	11.22	0.00	0.00
	None	16	7.80	0.00	0.00
	Blank	7	-	-	0.00
	Total	**212**	**100**		**39.8%**

Usable analytical n (205) does not include "blank" responses.

The question-specific responses were also judged for general understanding of the entire pictogram. Chi-square analysis revealed an association of cabin safety expertise [χ^2 (14, N=212) = 89.56, $p < .01$] and flight history [χ^2 (21, N=212) = 55.18, $p < .01$] with comprehension. Without the responses from the Cabin Safety experts, the composite comprehension score fell to only 26.1%.

The Type 0 scores were then scored for general information relative to overall comprehension of the pictogram.

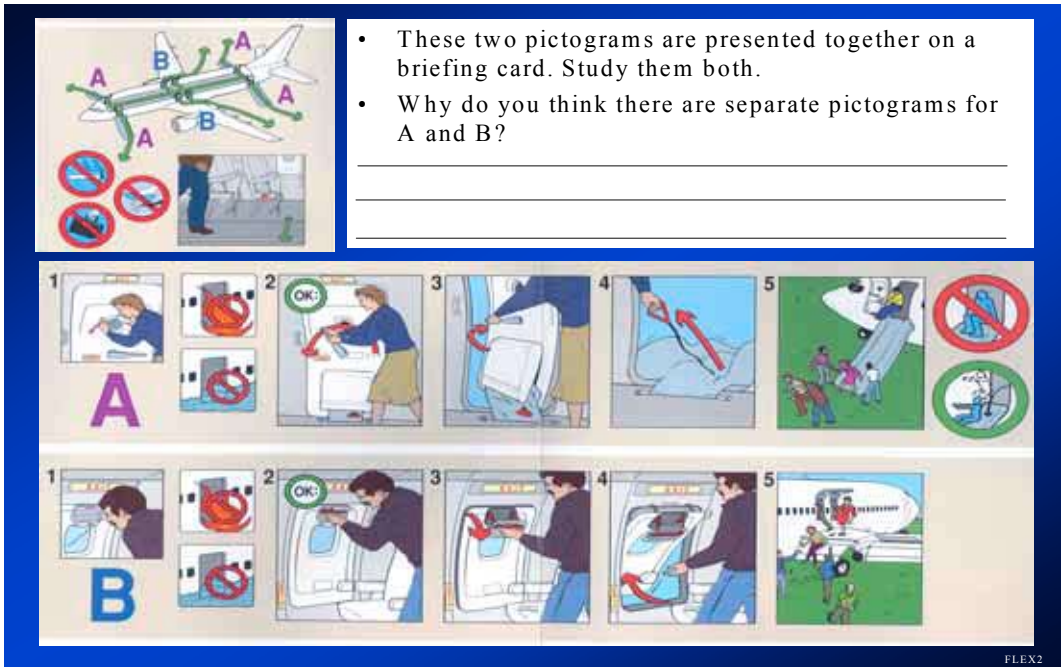
Warning (W1) Type 0 Composite Score

Response Type	Comprehension Category	Frequency	Percent	Weight	Comprehension Score
0	Likely	1	2.44	0.75	1.83
	Arguable	14	34.14	0.50	17.07
	Suspect	24	58.54	0.25	14.64
	Wrong	2	4.88	0.00	0.00
	Total	**41**	**100**		**33.5%**

Comprehension Category	Typical Type 0 Responses
Likely	There are 6 exits marked by lights, go to them and check the windows before opening/inflating emergency hatch. Then jump (not sit) on the slide and run off.
Arguable	It tells you where the exits are and in what weather not to leave the plane. Also shows how to leave the plane and not to smoke, carry luggage, and that the area may be slick.
Suspect	In case of emergency, here are some exits.
Wrong	How to handle hazards.

An overall comprehension score for the pictogram was derived from combining both the Type 1 composite comprehension score and the comprehension score produced by categorization of the Type 0 responses, which were related to the general essence of the pictorial/pictogram, as opposed to the question-specific content being sought. A weighted average of the Type 1 and Type 0 composite comprehension scores suggests general overall comprehension of about 38.8%.

7.



Emergency Exits (FLEX2)

Comprehension criterion: Pictogram A presents operating instructions for a floor-level exit and pictogram B presents operating instructions for an overwing exit.

Emergency Exits (FLEX2) Question Score

Response Type	Comprehension Category	Frequency	Percent	Weight	Comprehension Score
1	Certain	19	16.81	1.00	16.81
	Likely	36	31.86	0.75	23.90
	Arguable	29	25.66	0.50	12.83
	Suspect	19	16.81	0.25	4.20
	Wrong	8	7.08	0.00	0.00
	None	2	1.77	0.00	0.00
	Blank	1	-	-	0.00
	Total	**114**	**100**		**57.7%***

Usable analytical n (113) does not include "blank" responses.

* Of the 125 subjects who received this emergency exits pictogram, 113 (90.4%) attempted to answer the specific question asked about the pictorials, whereas 11 subjects (8.8%) responded with general information about other elements of the pictogram, and one subject failed to respond at all. Chi-square analysis revealed an association of cabin safety expertise [χ^2 (10, N = 113) = 45.20, $p < .01$] and number of flights [χ^2 (15, N = 113) = 31.48, $p < .01$] with comprehension.

Comprehension Category	Typical Type 1 Responses
Certain	A is giving directions on how to evacuate using the doors. B is giving direction on how to open the over wing exit. They are two different types of exits on the aircraft.
Likely	One shows how to get out on wing the other shows how to get out at other spots.
Arguable	Two different doors.
Suspect	Smaller area of evacuation
Wrong	They are two different wings to the plane.

Emergency Exits (FLEX2) Composite Score

Response Type	Comprehension Category	Frequency	Percent	Weight	Comprehension Score
1	Certain	22	19.47	1.00	19.47
	Likely	36	31.86	0.75	23.89
	Arguable	29	25.66	0.50	12.83
	Suspect	17	15.04	0.25	3.76
	Wrong	7	6.19	0.00	0.00
	None	2	1.77	0.00	0.00
	Blank	1	-	-	0.00
	Total	**114**	**100**		**60.0%***

Usable analytical n (113) does not include "blank" responses.

* The 114 question-specific responses were also judged for general understanding of the entire pictogram. Chi-square analysis revealed an association of cabin safety expertise [χ^2 (10, N = 113) = 41.09, $p < .01$] and number of flights [χ^2 (15, N = 113) = 29.12, p = .02] with comprehension. Without the responses from Cabin Safety experts, the composite comprehension score fell to 51.4%.

The Type 0 scores were then scored for general information relative to overall comprehension of the pictogram.

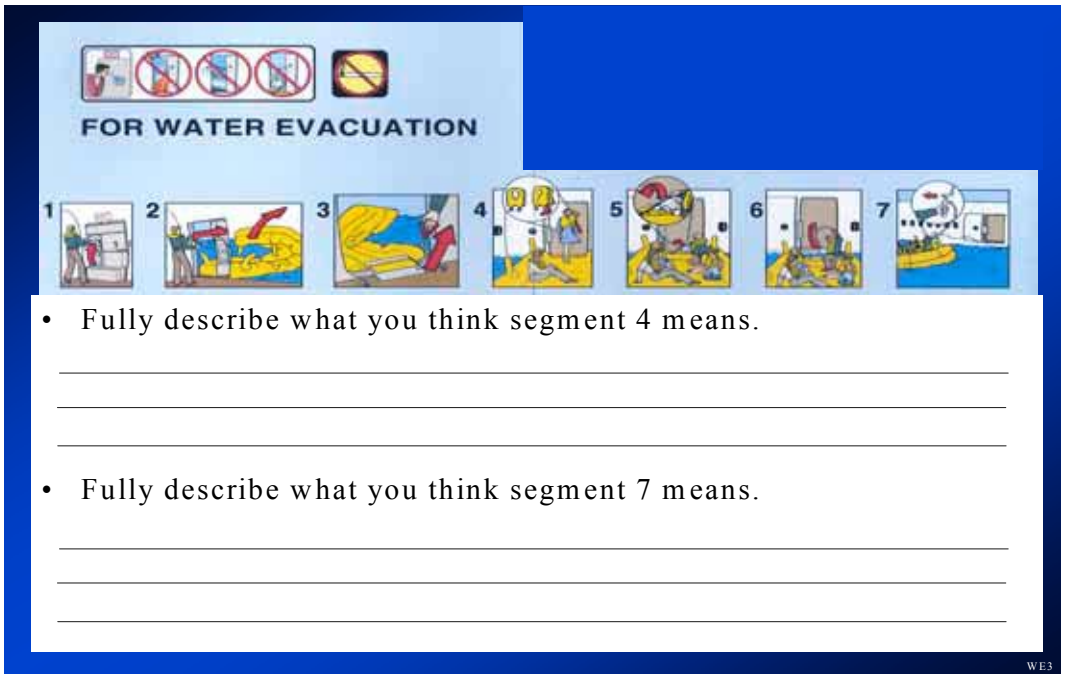
Emergency Exits (FLEX2) Type 0 Composite Score

Response Type	Comprehension Category	Frequency	Percent	Weight	Comprehension Score
0	Likely	3	27.27	0.75	20.45
	Arguable	4	36.36	0.50	18.18
	Suspect	2	18.18	0.25	4.55
	Wrong	2	18.18	0.00	0.00
	Total	**11**	**100**		**43.2%**

Comprehension Category	Typical Type 0 Responses
Likely	Where the exits are located and what not to take.
Arguable	Exits out of the plane.
Suspect	Fire and water exit.
Wrong	Air flow.

An overall comprehension score for the pictogram was derived from combining both the Type 1 composite comprehension score and the comprehension score produced by categorization of the Type 0 responses, which were related to the general essence of the pictorial/pictogram, as opposed to the question-specific content being sought. A weighted average of the Type 1 and Type 0 composite comprehension scores suggests general overall comprehension of about 58.5%.

8.



Water Evacuation (WE3)

(a.) Comprehension criterion: Inflate your lifevest at or outside the exit as you prepare to board the life raft.

Water Evacuation (WE3) Question (a) Score

Response Type	Comprehension Category	Frequency	Percent	Weight	Comprehension Score
1	Certain	27	20.93	1.00	20.93
	Likely	28	21.71	0.75	16.28
	Arguable	39	30.23	0.50	15.12
	Suspect	22	17.05	0.25	4.26
	Wrong	12	9.30	0.00	0.00
	None	1	0.78	0.00	0.00
	Blank	1	-	-	0.00
	Total	**130**	**100**		**56.6%***

Usable analytical n (129) does not include "blank" responses.

* Of the 130 subjects who received this water evacuation pictogram, 129 (99.2%) answered the specific question asked about the segment 4 pictorial, and one subject failed to respond. Chi-square revealed an association of cabin safety expertise [χ^2 (12, N = 130) = 57.48, $p < .01$] and number of flights [χ^2 (15, N = 130) = 96.45, $p < .01$] with comprehension.

Comprehension Category	Typical Type 1 Responses
Certain	Inflate vest upon exiting aircraft.
Likely	Pull cord to inflate the life vest.
Arguable	Wear safety vest when exiting over water.
Suspect	Life jackets are available.
Wrong	The lady's life vest is not inflated right.

(b.) Segment 7 comprehension criterion: Use the knife in the survival kit to cut the line tethering the life raft to the airplane.

Water Evacuation (WE3) Question (b) Score

Response Type	Comprehension Category	Frequency	Percent	Weight	Comprehension Score
1	Certain	71	55.91	1.00	55.91
	Likely	20	15.75	0.75	11.81
	Arguable	15	11.81	0.50	5.91
	Suspect	10	7.87	0.25	1.97
	Wrong	9	7.09	0.00	0.00
	None	2	1.57	0.00	0.00
	Blank	3	-	-	0.00
	Total	**130**	**100**		**75.6%***

Usable analytical n (127) does not include "blank" responses.

* Of the 130 subjects who received this water evacuation pictogram, 127 (97.7%) subjects answered the specific question asked about the segment 7 pictorial, and three failed to respond. Chi-square analysis revealed that comprehension was not differentially associated with cabin safety expertise or flight history.

Comprehension Category	Typical Type 1 Responses
Certain	Cut lanyard securing raft to aircraft using raft knife.
Likely	You must disconnect the life raft from the plane so the plane doesn't drag it down.
Arguable	What you should do to cut the rope.
Suspect	Pull on the cord to release the raft.
Wrong	Hold on in case of emergency.

Water Evacuation (WE3) Composite Score

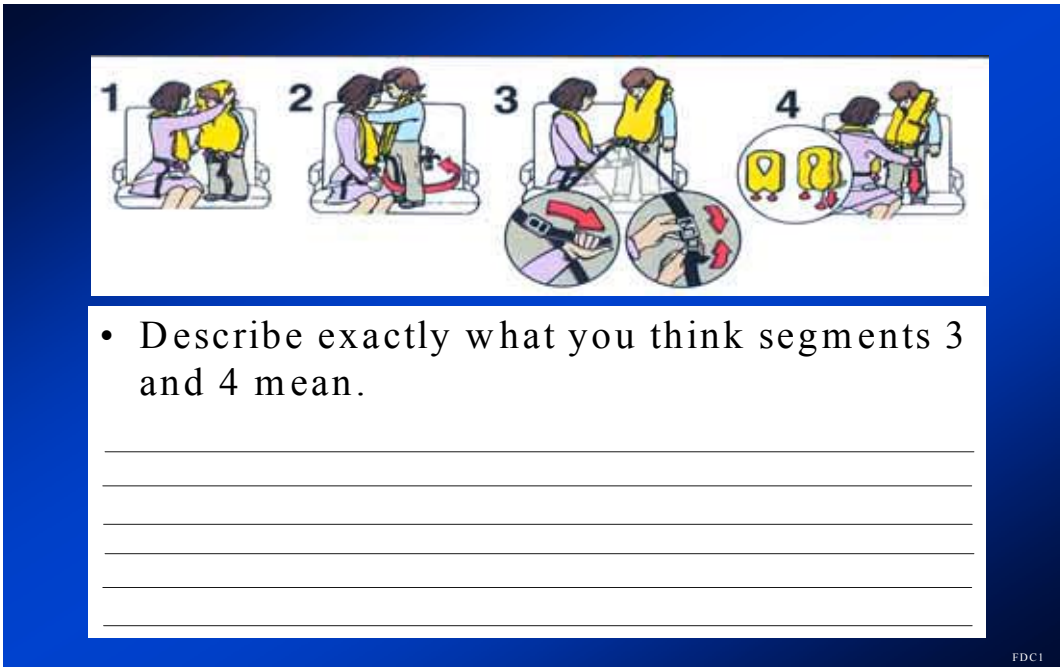
Response Type	Comprehension Category	Frequency	Percent	Weight	Comprehension Score
1	Certain	31	24.03	1.00	24.03
	Likely	46	35.66	0.75	26.75
	Arguable	36	27.91	0.50	13.96
	Suspect	9	6.98	0.25	1.75
	Wrong	5	3.88	0.00	0.00
	None	2	1.55	0.00	0.00
	Blank	1	-	-	0.00
	Total	**130**	**100**		**66.5%***

Usable analytical n (129) does not include "blank" responses.

* The combined question-specific Type 1 responses were also judged for general understanding of the entire pictogram. Chi-square revealed an association of cabin safety expertise [χ^2 (12, N = 130) = 43.94, $p < .01$] and number of flights [χ^2 (15, N = 130) = 57.29, $p < .01$] with comprehension. Without the responses from Cabin Safety experts, the composite comprehension score fell to 60.2%.

The lack of Type 0 responses produced an identical overall comprehension score.

9.



Flotation Device Usage (FDC1)

(a.) Comprehension criterion: Buckle the lifevest straps and tighten.

Flotation Device Usage (FDC1) Question (a) Score

Response Type	Comprehension Category	Frequency	Percent	Weight	Comprehension Score
1	Certain	45	17.37	1.00	17.37
	Likely	40	15.44	0.75	11.58
	Arguable	65	25.10	0.50	12.55
	Suspect	42	16.22	0.25	4.06
	Wrong	57	22.01	0.00	0.00
	None	10	3.86	0.00	0.00
	Blank	6	-	-	0.00
	Total	**265**	**100**		**45.6%***

Usable analytical n (259) does not include "blank" responses.

* Of the 265 subjects who received this flotation device usage, 259 (97.7%) answered question (a), and six failed to respond. Chi-square analysis revealed an association of cabin safety expertise [χ^2 (12, N = 265) = 65.65, p < .01] and number of flights [χ^2 (18, N = 265) = 58.89, p < .01] with comprehension.

Comprehension Category	Typical Type 1 Responses
Certain	Buckle the life vest strap and tighten.
Likely	Tighten the waist strap.
Arguable	How to buckle.
Suspect	Make sure it's on completely.
Wrong	Attach strap from mother to child and another to the seat.

(b). Comprehension criterion: Inflate the vest by pulling down on the red tab.

Flotation Device Usage (FDC1) Question (b) Score

Response Type	Comprehension Category	Frequency	Percent	Weight	Comprehension Score
1	Certain	34	15.11	1.00	15.11
	Likely	91	40.44	0.75	30.33
	Arguable	49	21.78	0.50	10.89
	Suspect	9	4.00	0.25	1.00
	Wrong	36	16.00	0.00	0.00
	None	6	2.67	0.00	0.00
	Blank	40	-	-	0.00
	Total	**265**	**100**		**57.3%***

Usable analytical n (225) does not include "blank" responses.

* Of the 265 subjects who received this flotation device usage, 225 (84.9%) subjects answered question (b), and 40 failed to respond. Chi-square analysis revealed an association of cabin safety expertise [χ^2 (12, N = 265) = 98.51, $p < .01$] and number of flights [χ^2 (18, N = 265) = 81.31, $p < .01$] with comprehension.

Comprehension Category	Typical Type 1 Responses
Certain	Inflate one chamber by pulling the cord.
Likely	Pull down to inflate.
Arguable	Inflate.
Suspect	Pull on straps.
Wrong	Take off seatbelt.

Flotation Device Usage (FDC1) Composite Score

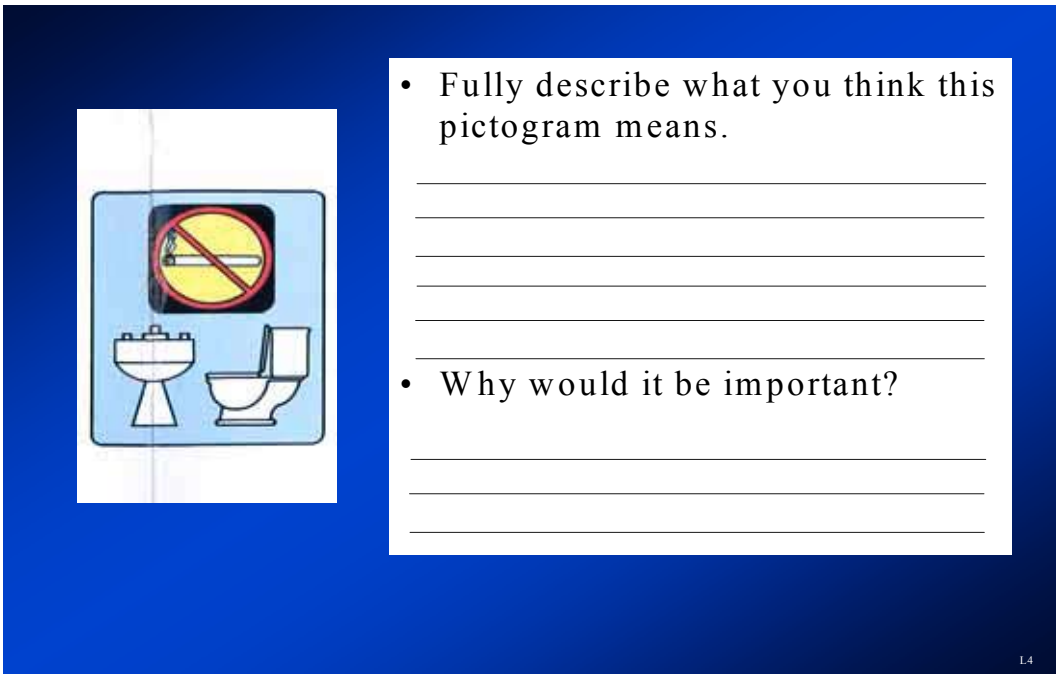
Response Type	Comprehension Category	Frequency	Percent	Weight	Comprehension Score
1	Certain	22	8.46	1.00	8.46
	Likely	66	25.38	0.75	19.04
	Arguable	76	29.23	0.50	14.62
	Suspect	55	21.15	0.25	5.29
	Wrong	36	13.85	0.00	0.00
	None	5	1.92	0.00	0.00
	Blank	5	-	-	0.00
	Total	**265**	**100**		**47.4%***

Usable analytical n (260) does not include "blank" responses.

* The combined question-specific Type 1 responses were also judged for general understanding of the entire pictogram. Chi-square analysis revealed an association of cabin safety expertise [χ^2 (12, N = 265) = 86.02, $p < .01$] and number of flights [χ^2 (18, N = 265) = 68.78, $p < .01$] with comprehension. Without the responses from Cabin Safety experts, the composite comprehension score fell to 41.0%.

The lack of Type 0 responses produced an identical overall comprehension score.

10.



No Smoking in Lavatory (L4)

(a.) Comprehension criterion: No smoking in lavatory.

No Smoking in Lavatory (L4) Question (a) Score

Response Type	Comprehension Category	Frequency	Percent	Weight	Comprehension Score
1	Certain	126	93.33	1.00	93.33
	Likely	5	3.70	0.75	2.78
	Suspect	1	0.74	0.25	0.19
	Wrong	2	1.48	0.00	0.00
	None	1	0.74	0.00	0.00
	Total	**135**	**100**		**96.3%**

All 135 (100%) subjects who received this no smoking in lavatory pictorial answered question (a). Chi-square analysis revealed that comprehension was not differentially associated with cabin safety expertise or flight history.

Comprehension Category	Typical Type 1 Responses
Certain	Do not smoke in the lavatory.
Likely	No smoking.
Suspect	Do not sneak in the bathroom to smoke a cigarette.
Wrong	Don't put cigarettes into sink or toilet.

(b.) Comprehension criterion: There is a danger of causing a fire.

No Smoking in Lavatory (L4) Question (b) Score

Response Type	Comprehension Category	Frequency	Percent	Weight	Comprehension Score
1	Certain	58	43.28	1.00	43.28
	Likely	6	4.48	0.75	3.36
	Arguable	21	15.67	0.50	7.84
	Suspect	35	26.12	0.25	6.53
	Wrong	8	5.97	0.00	0.00
	None	6	4.48	0.00	0.00
	Blank	1	-	-	0.00
	Total	**135**	**100**		**61.0%**

Usable analytical n (134) does not include "blank" responses.

Of the 135 subjects who received this no smoking in lavatory pictorial, 134 subjects (99.3%) answered question (b). Chi-square analysis revealed that comprehension was not differentially associated with cabin safety expertise or flight history.

Comprehension Category	Typical Type 1 Responses
Certain	You could start a fire.
Likely	Start a fire or stop up sink or toilet.
Arguable	Because it is against the law and you could be fined.
Suspect	Smoking can set off the smoke or fire alarm.
Wrong	Smoking can disturb cabin pressure.

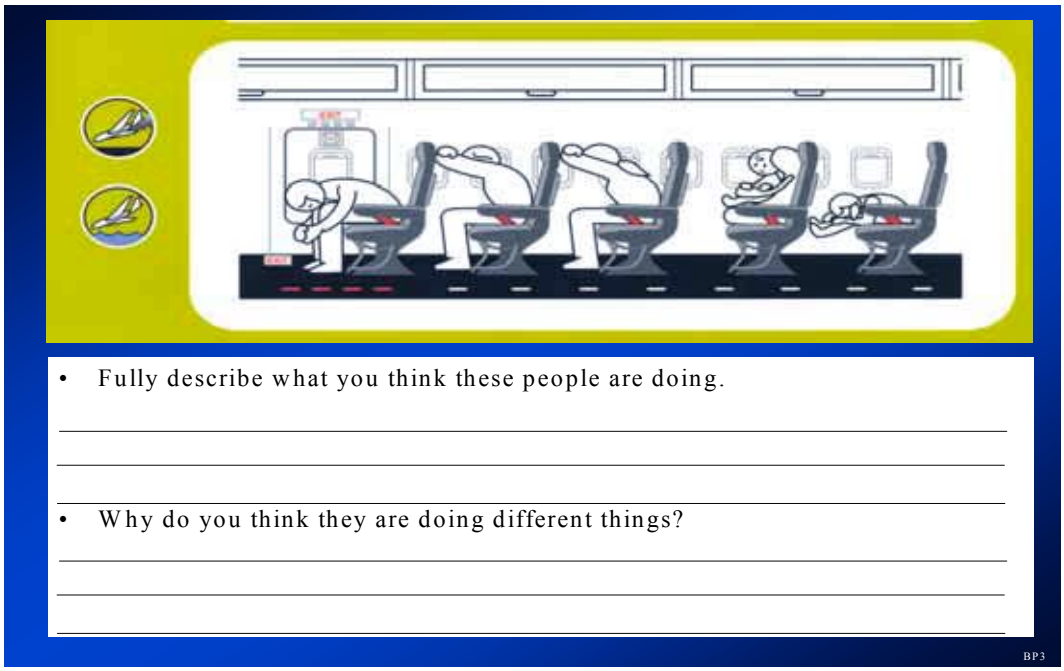
No Smoking in Lavatory (L4) Composite Score

Response Type	Comprehension Category	Frequency	Percent	Weight	Comprehension Score
1	Certain	58	42.96	1.00	42.96
	Likely	23	17.04	0.75	12.78
	Arguable	49	36.30	0.50	18.15
	Suspect	4	2.96	0.25	0.74
	None	1	0.74	0.00	0.00
	Total	**135**	**100**		**74.6%**

The combined question-specific Type 1 responses were also judged for general understanding of the entire pictogram. Chi-square analysis revealed that comprehension was not differentially associated with cabin safety expertise or flight history.

The lack of Type 0 responses produced an identical overall comprehension score.

11.



Brace Position (BP3)

(a.) Comprehension criterion: Assume the brace position for impact or emergency landing.

Brace Position (BP3) Question (a) Score

Response Type	Comprehension Category	Frequency	Percent	Weight	Comprehension Score
1	Certain	73	58.87	1.00	58.87
	Likely	20	16.13	0.75	12.10
	Arguable	12	9.68	0.50	4.84
	Suspect	5	4.03	0.25	1.01
	Wrong	14	11.29	0.00	0.00
	Blank	2	-	-	0.00
	Total	**126**	**100**		**76.8%***

Usable analytical n (124) does not include "blank" responses.

* Of the 126 subjects who received this brace position pictorial, 124 (98.4%) answered question (a), and two failed to respond. Chi-square analysis revealed an association of cabin safety expertise [χ^2 (10, N = 126) = 20.39, p = .03], with no association of number of flights, with comprehension.

Comprehension Category	Typical Type 1 Responses
Certain	They are all showing different bracing positions for either a land ditching or emergency landing.
Likely	They are trying to protect themselves from really injuring themselves.
Arguable	They are ducking for cover.
Suspect	Doing as told.
Wrong	Sleeping.

(b.) Comprehension criterion: <u>They are of different sizes and some have a seat to lean against whereas others do not.</u>

Brace Position (BP3) Question (b) Score

Response Type	Comprehension Category	Frequency	Percent	Weight	Comprehension Score
1	Certain	41	33.06	1.00	33.06
	Likely	30	24.19	0.75	18.14
	Arguable	18	14.52	0.50	7.26
	Suspect	9	7.26	0.25	1.82
	Wrong	24	19.35	0.00	0.00
	None	2	1.61	0.00	0.00
	Blank	2	-	-	0.00
	Total	**126**	**100**		**60.3%***

Usable analytical n (124) does not include "blank" responses.

* Of the 126 subjects who received this brace position pictorial, 124 (98.4%) subjects answered question (b), and two failed to respond. Chi-square analysis revealed an association of cabin safety expertise [χ^2 (12, N = 126) = 25.17, $p < .01$], with no association of number of flights, with comprehension.

Comprehension Category	Typical Type 1 Responses
Certain	Depending on where they sit and how old they are. Front can go low where the next two cannot; children should be strapped in seats.
Likely	Various methods of body protection for adults and children.
Arguable	Because they are different ages.
Suspect	The room provided
Wrong	They were not properly informed.

Brace Position (BP3) Composite Score

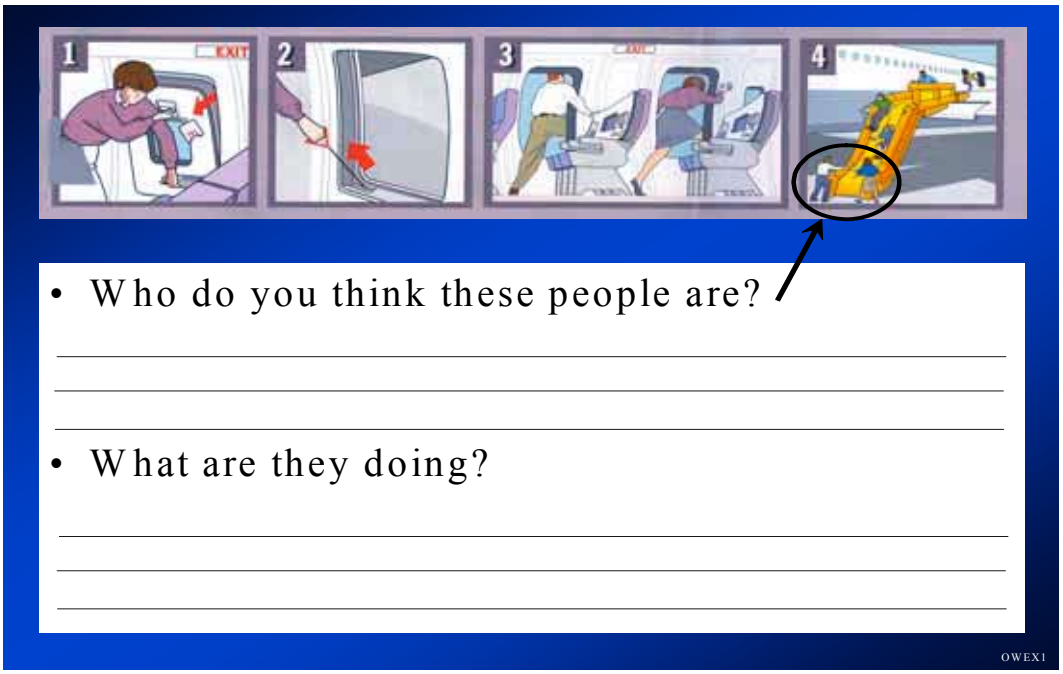
Response Type	Comprehension Category	Frequency	Percent	Weight	Comprehension Score
1	Certain	49	39.52	1.00	39.52
	Likely	32	25.81	0.75	19.36
	Arguable	19	15.32	0.50	7.66
	Suspect	10	8.06	0.25	2.02
	Wrong	14	11.29	0.00	0.00
	Blank	2	-	-	0.00
	Total	**126**	**100**		**68.6%***

Usable analytical n (124) does not include "blank" responses.

* The combined question-specific Type 1 responses were also judged for general understanding of the entire pictogram. Chi-square analysis revealed an association of cabin safety expertise [χ^2 (10, N = 126) = 24.39, $p < .01$], with no association of number of flights, with comprehension. Without the responses from Cabin Safety experts, the composite comprehension score fell to 64.0%.

The lack of Type 0 responses produced an identical overall comprehension score.

12.



Emergency Exits (OWEX1)

(a.) Comprehension criterion: Able-bodied passengers who have already evacuated and are assisting with the evacuation.

Emergency Exits (OWEX1) Question (a) Score

Response Type	Comprehension Category	Frequency	Percent	Weight	Comprehension Score
1	Certain	72	57.60	1.00	57.60
	Likely	16	12.80	0.75	9.60
	Arguable	10	8.00	0.50	4.00
	Suspect	3	2.40	0.25	0.60
	Wrong	24	19.20	0.00	0.00
	Blank	1	-	-	0.00
	Total	**126**	**100**		**71.8%***

Usable analytical n (125) does not include "blank" responses.

*Of the 128 subjects who received this emergency exits pictorial, 125 (97.7%) answered question (a), whereas two subjects (1.9%) responded with general information about other elements of the pictogram, and one failed to respond at all. Chi-square analysis revealed that comprehension was not differentially associated with cabin safety expertise or flight history.

Comprehension Category	Typical Type 1 Responses
Certain	First passengers who left the aircraft
Likely	Evacuees
Arguable	People in a dangerous situation.
Suspect	They crashed and the plane is on fire and they can't take the regular stairs.
Wrong	Flight attendants.

(b.) Comprehension criterion: Helping other passengers get off the slide during an emergency evacuation.

Emergency Exits (OWEX1) Question (b) Score

Response Type	Comprehension Category	Frequency	Percent	Weight	Comprehension Score
1	Certain	71	56.80	1.00	56.80
	Likely	2	1.60	0.75	1.20
	Arguable	8	6.40	0.50	3.20
	Suspect	36	28.80	0.25	7.20
	Wrong	8	6.40	0.00	0.00
	Blank	1	-	-	0.00
	Total	**126**	**100**		**68.4%***

Usable analytical n (125) does not include "blank" responses.

*Of the 128 subjects who received this emergency exits pictorial, 125 (97.7%) answered question (b), whereas two subjects (1.9%) responded with general information about other elements of the pictogram, and one failed to respond at all. Chi-square analysis revealed that comprehension was not differentially associated with cabin safety expertise or flight history.

Comprehension Category	Typical Type 1 Responses
Certain	Helping other passengers get off the slide.
Likely	Helping everyone get out safely.
Arguable	Catching the old people.
Suspect	Evacuating.
Wrong	Leaving by slide instead of waiting for the plane to pull to the terminal.

Emergency Exits (OWEX1) Composite Score

Response Type	Comprehension Category	Frequency	Percent	Weight	Comprehension Score
1	Certain	49	39.20	1.00	39.20
	Likely	6	4.80	0.75	3.60
	Arguable	15	12.00	0.50	6.00
	Suspect	51	40.80	0.25	10.20
	Wrong	4	3.20	0.00	0.00
	Blank	1	-	-	0.00
	Total	**126**	**100**		**59.0%***

Usable analytical n (125) does not include "blank" responses.

* The combined question-specific Type 1 responses were also judged for general understanding of the entire pictogram. Chi-square analysis revealed an association of cabin safety expertise [χ^2 (10, N=126) = 40.55, $p < .01$], with no association of number of flights, with comprehension. Without the responses from Cabin Safety experts, the composite comprehension score fell to 51.3%.

The Type 0 responses were then categorized for general information relative to overall comprehension of the pictogram.

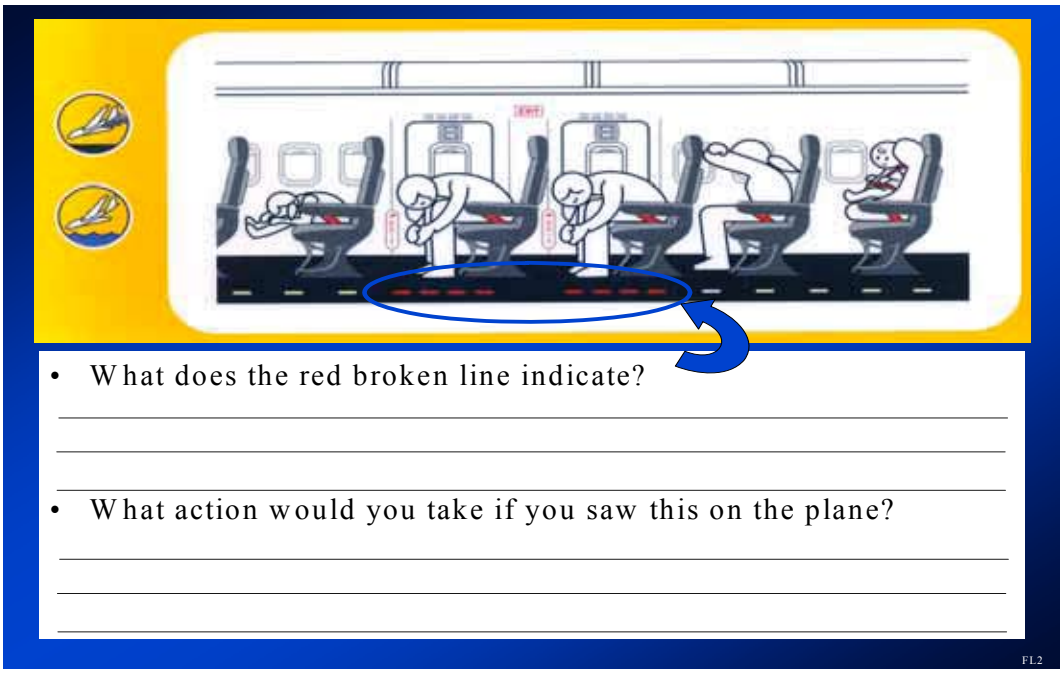
Emergency Exits (OWEX1) Type 0 Composite Score

Response Type	Comprehension Category	Frequency	Percent	Weight	Comprehension Score
0	Arguable	1	50.00	0.50	25.00
	Suspect	1	50.00	0.25	12.50
	Total	**2**	**100**		**37.5%**

Comprehension Category	Typical Type 0 Responses
Arguable	Open window exit, pull red handle, exit through window.
Suspect	Exiting through window to get to safety.

An overall comprehension score for the pictogram was derived from combining both the Type 1 composite comprehension score and the comprehension score produced by categorization of the Type 0 responses, which were related to the general essence of the pictorial/pictogram, as opposed to the question-specific content being sought. A weighted average of the Type 1 and Type 0 composite comprehension scores suggests general overall comprehension of about 58.9%.

13.



Floor Marking of Exits (FL2)

(a.) Comprehension criterion: Passageways leading to overwing emergency exits.

Floor Marking of Exits (FL2) Question (a) Score

Response Type	Comprehension Category	Frequency	Percent	Weight	Comprehension Score
1	Certain	202	79.22	1.00	79.22
	Likely	11	4.31	0.75	3.23
	Arguable	6	2.35	0.50	1.18
	Suspect	7	2.75	0.25	0.69
	Opposite	4	1.57	-1.00	-1.57
	Wrong	20	7.84	0.00	0.00
	None	5	1.96	0.00	0.00
	Blank	4	-	-	0.00
	Total	**259**	**100**		**82.8%***

Usable analytical n (255) does not include “blank” responses.

* Of the 264 subjects who received this floor marking of exits pictogram, 255 (96.6%) specifically answered question (a), whereas five subjects (1.9%) responded with general information about other elements of the pictogram and four subjects failed to respond at all.

Comprehension Category	Typical Type 1 Responses
Certain	Red lights to indicate the presence of an exit door on that row.
Likely	There is an emergency exit nearby.
Arguable	Emergency exit lights.
Suspect	Lights.
Opposite	The exit will not open.
Wrong	They are doing something wrong, the lights are lit up.

(b.) Comprehension criterion: Turn into the passageway from the aisle to get to the emergency exit.

Floor Marking of Exits (FL2) Question (b) Score

Response Type	Comprehension Category	Frequency	Percent	Weight	Comprehension Score
1	Certain	128	51.00	1.00	51.00
	Likely	33	13.15	0.75	9.86
	Arguable	30	11.95	0.50	5.98
	Suspect	29	11.55	0.25	2.89
	Opposite	3	1.20	-1.00	-1.20
	Wrong	21	8.37	0.00	0.00
	None	7	2.79	0.00	0.00
	Blank	8	-	-	0.00
	Total	**259**	**100**		**68.5%***

Usable analytical n (251) does not include "blank" responses.

* Of the 264 subjects who received this floor marking of exits pictogram, 251 (95.1%) specifically answered question (b), whereas five subjects (1.9%) responded with general information about other elements of the pictogram, and eight subjects failed to respond at all. Chi-square analysis revealed an association of cabin safety expertise [χ^2 (14, N = 259) = 42.28, $p < .01$], and number of flights [χ^2 (21, N = 259) = 49.63, $p < .01$], with comprehension.

Comprehension Category	Typical Type 1 Responses
Certain	If there was an evacuation, I would know to turn at the red lights to find an exit.
Likely	Take note of where the emergency doors were.
Arguable	Tell them to move because they are blocking the exits.
Suspect	I would do the same thing these people are doing.
Opposite	Choose a different door through which to exit the plane.
Wrong	Get a flight attendant.

Floor Marking of Exits (FL2) Composite Score

Response Type	Comprehension Category	Frequency	Percent	Weight	Comprehension Score
1	Certain	128	50.00	1.00	50.00
	Likely	35	13.67	0.75	10.25
	Arguable	52	20.31	0.50	10.15
	Suspect	17	6.64	0.25	1.66
	Opposite	2	0.78	-1.00	-0.78
	Wrong	19	7.42	0.00	0.00
	None	3	1.17	0.00	0.00
	Blank	3	-	-	0.00
	Total	**259**	**100**		**71.3%***

Usable analytical n (256) does not include "blank" responses.

* The combined question-specific Type 1 responses were also judged for general understanding of the entire pictogram. Chi-square analysis revealed an association of cabin safety expertise [χ^2 (14, N = 259) = 42.37, $p < .01$], with no association of number of flights [χ^2 (21, N = 259) = 46.45, $p < .01$], with comprehension. Without the responses from Cabin Safety experts, the composite comprehension score fell to 67%.

The Type 0 responses were then categorized for general information relative to overall comprehension of the pictogram.

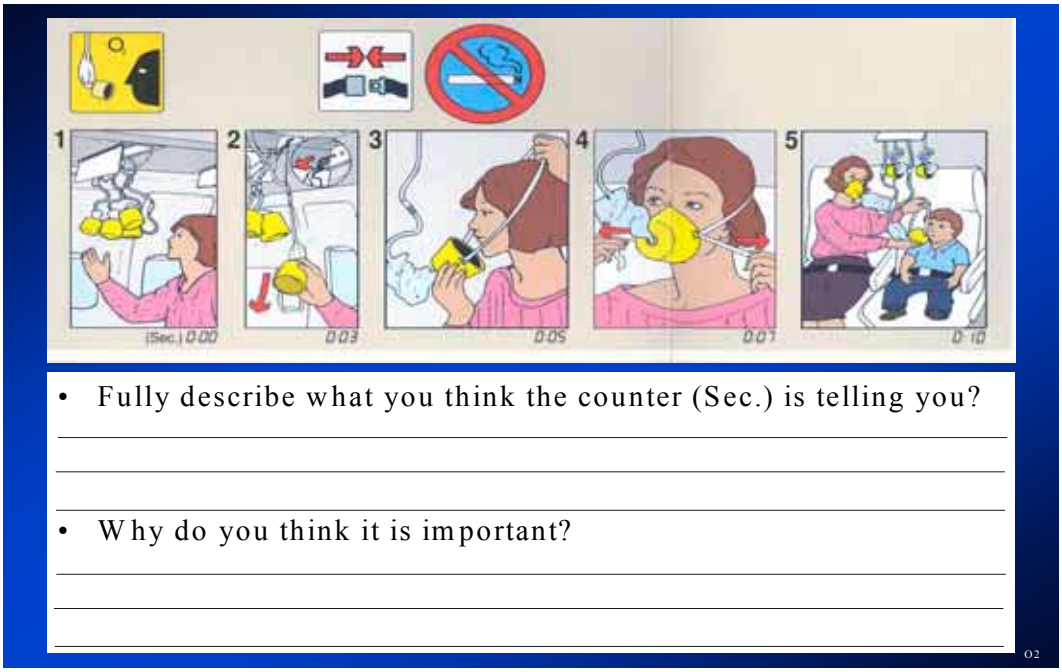
Floor Marking of Exits (FL2) Type 0 Composite Score

Response Type	Comprehension Category	Frequency	Percent	Weight	Comprehension Score
0	Suspect	3	60.00	0.25	15.00
	Wrong	2	40.00	0.00	0.00
	Total	**5**	**100**		**15.0%**

Comprehension Category	Typical Type 0 Responses
Suspect	Brace according to seat location.
Wrong	Do not do that.

An overall comprehension score for the pictogram was derived from combining both the Type 1 composite comprehension score and the comprehension score produced by categorization of the Type 0 responses, which were related to the general essence of the pictorial/pictogram, as opposed to the question-specific content being sought. A weighted average of the Type 1 and Type 0 composite comprehension scores suggests general overall comprehension of about 70.2%.

14.



Oxygen Equipment Usage (O2)

(a.) Comprehension criterion: The maximum number of seconds a passenger should take to don his/her mask and help someone else don theirs.

Oxygen Equipment Usage (O2) Question (a) Score

Response Type	Comprehension Category	Frequency	Percent	Weight	Comprehension Score
1	Certain	32	18.71	1.00	18.71
	Likely	54	31.58	0.75	23.69
	Arguable	71	41.52	0.50	20.76
	Suspect	14	8.19	0.25	2.05
	Blank	5	-	-	0.00
	Total	**176**	**100**		**65.2%**

Usable analytical n (171) does not include "blank" responses.

* Of the 264 subjects who received this oxygen equipment usage pictogram, 171 (64.8%) answered question (a), whereas 88 subjects (33.3%) responded with general information about other elements of the pictogram, and five subjects failed to respond at all. Chi-square analysis revealed that comprehension was not differentially associated with cabin safety expertise or flight history.

Comprehension Category	Typical Type 1 Responses
Certain	The counter is telling you that you need to be able to put your mask on this quickly.
Likely	It is a time reference to let you know how fast things should happen.
Arguable	Time it takes to see the masks deploy, know to respond, your action taken, to secure your mask first before helping others.
Suspect	On average, how long it would take to put the mask on.

(b.) Comprehension criterion: The amount of oxygen in the atmosphere at very high altitudes is very small and a passenger can become incapacitated very quickly.

Oxygen Equipment Usage (O2) Question (b) Score

Response Type	Comprehension Category	Frequency	Percent	Weight	Comprehension Score
1	Certain	32	17.49	1.00	17.49
	Likely	60	32.79	0.75	24.59
	Arguable	52	28.42	0.50	14.21
	Suspect	26	14.21	0.25	3.55
	Opposite	1	0.55	-1.00	-0.55
	Wrong	10	5.46	0.00	0.00
	None	2	1.09	0.00	0.00
	Blank	7	-	-	0.00
	Total	**190**	**100**		**59.3%**

Usable analytical n (183) does not include “blank” responses.

* Of the 264 subjects who received this oxygen equipment usage pictogram, 183 subjects (69.3%) answered question (b), whereas 74 subjects (28.0%) responded with general information about other elements of the pictogram, and seven subjects failed to respond at all. Chi-square analysis revealed that comprehension was not differentially associated with cabin safety expertise or flight history.

Comprehension Category	Typical Type 1 Responses
Certain	You only have limited time before experiencing symptoms related to oxygen deprivation.
Likely	Alerts people that they have to act quickly.
Arguable	It is important to don your mask first so that you could be of help to your child.
Suspect	So you can be able to breath with the amount of oxygen.
Opposite	I don’t think it is important.
Wrong	Because most people do not know what to do.

Oxygen Equipment Usage (O2) Composite Score

Response Type	Comprehension Category	Frequency	Percent	Weight	Comprehension Score
1	Certain	28	15.30	1.00	15.30
	Likely	74	40.44	0.75	30.33
	Arguable	53	28.96	0.50	14.48
	Suspect	27	14.75	0.25	3.69
	Wrong	1	0.55	0.00	0.00
	Blank	5	-	-	0.00
	Total	**188**	**100**		**63.8%**

Usable analytical n (183) does not include "blank" responses.

The combined question-specific Type 1 responses were also judged for general understanding of the entire pictogram. Chi-square analysis revealed that comprehension was not differentially associated with cabin safety expertise or flight history.

The Type 0 responses were then categorized for general information relative to overall comprehension of the pictogram.

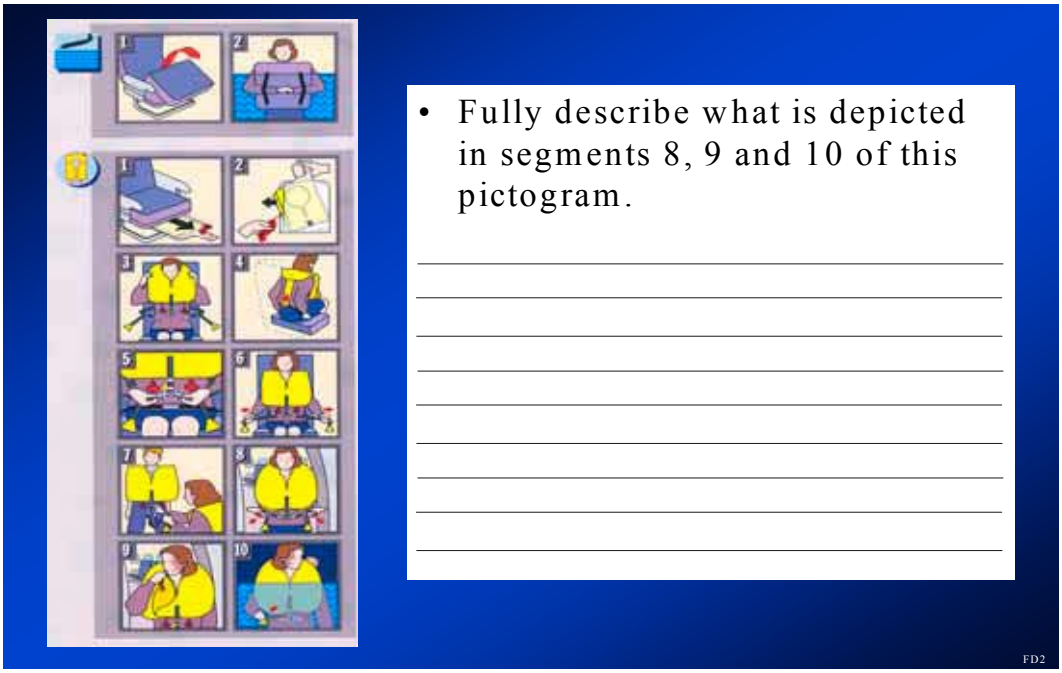
Oxygen Equipment Usage (O2) Type 0 Composite Score

Response Type	Comprehension Category	Frequency	Percent	Weight	Comprehension Score
0	Likely	23	30.67	0.75	23.00
	Arguable	29	38.67	0.50	19.33
	Suspect	21	28.00	0.25	7.00
	Wrong	2	2.66	0.00	0.00
	Total	**75**	**100**		**49.3%**

Comprehension Category	Typical Type 0 Responses
Likely	How to put on you air mask so you can breathe if something happens to the cabin pressure.
Arguable	How to apply the breathing mask so you can breathe if under danger.
Suspect	How to place the air bag on.
Wrong	If the plane crashes in water, you can breathe properly.

An overall comprehension score for the pictogram was derived from combining both the Type 1 composite comprehension score and the comprehension score produced by categorization of the Type 0 responses, which were related to the general essence of the pictorial/pictogram, as opposed to the question-specific content being sought. A weighted average of the Type 1 and Type 0 composite comprehension scores suggests general overall comprehension of about 59.7%.

15.



Flotation Device Usage (FD2)

(a.) Comprehension criterion: Once outside the airplane, pull down on the red tabs to inflate the lifevest.

Flotation Device Usage (FD2) Question (a) Score

Response Type	Comprehension Category	Frequency	Percent	Weight	Comprehension Score
1	Certain	15	5.88	1.00	5.88
	Likely	117	45.88	0.75	34.41
	Arguable	55	21.57	0.50	10.79
	Suspect	35	13.73	0.25	3.43
	Wrong	32	12.55	0.00	0.00
	None	1	0.39	0.00	0.00
	Blank	4	-	-	0.00
	Total	**259**	**100**		**54.5%***

Usable analytical n (255) does not include "blank" responses.

* Of the 263 subjects who received this flotation device usage pictogram, 255 (97.0%) answered question (a), whereas four subjects (1.5%) responded with general information about other elements of the pictogram, and four subjects failed to respond at all. Chi Square analysis revealed an association of cabin safety expertise [χ^2 (12, N = 258) = 35.65, p < .01] and number of flights [χ^2 (18, N = 258) = 38.47, p < .01] with comprehension.

Comprehension Category	Typical Type 1 Responses
Certain	At the door, pull down tabs to inflate.
Likely	Inflate the life jacket.
Arguable	Pull the strings at the bottom of the vest.
Suspect	Put on vest.
Wrong	Pull strings to tighten.

(b.) Comprehension criterion: Blow into the red tube for added inflation, if necessary.

Flotation Device Usage (FD2) Question (b) Score

Response Type	Comprehension Category	Frequency	Percent	Weight	Comprehension Score
1	Certain	39	15.66	1.00	15.66
	Likely	124	49.80	0.75	37.35
	Arguable	36	14.46	0.50	7.23
	Suspect	18	7.23	0.25	1.81
	Wrong	27	10.84	0.00	0.00
	None	5	2.01	0.00	0.00
	Blank	10	-	-	0.00
	Total	**259**	**100**		**62.1%***

Usable analytical n (249) does not include "blank" responses.

* Of the 263 subjects who received this flotation device usage pictogram, 249 (94.7%) answered question (b), whereas four subjects (1.9%) responded with general information about other elements of the pictogram and ten subjects failed to respond at all. Chi-square analysis revealed an association of cabin safety expertise [χ^2 (12, N = 258) = 37.61, p < .01] and number of flights [χ^2 (18, N = 258) = 32.95, p = .02] with comprehension.

Comprehension Category	Typical Type 1 Responses
Certain	If the life preserver fails to inflate with the handles, blow air into the device through the tube.
Likely	You can blow your life vest with a valve.
Arguable	Blow into tube.
Suspect	Inflate.
Wrong	Blow the whistle.

(b.) Comprehension criterion: Once in the water at night, pull tab to illuminate locator signal light.

Flotation Device Usage (FD2) Question (c) Score

Response Type	Comprehension Category	Frequency	Percent	Weight	Comprehension Score
1	Certain	36	14.52	1.00	14.52
	Likely	14	5.65	0.75	4.24
	Arguable	7	2.82	0.50	1.41
	Suspect	86	34.68	0.25	8.67
	Wrong	84	33.87	0.00	0.00
	None	21	8.47	0.00	0.00
	Blank	11	-	-	0.00
	Total	**259**	**100**		**28.8%***

Usable analytical n (248) does not include "blank" responses.

Comprehension Category	Typical Type 1 Responses
Certain	Pull tab to activate light when in the water.
Likely	How to activate the emergency light of the vest
Arguable	Pull the tab inside the water.
Suspect	Float in the water using the vest.
Wrong	Pull life jacket to expand.

* Of the 263 subjects who received this flotation device usage pictogram, 248 (94.3%) answered question(c), whereas four subjects responded with general information about other elements of the pictogram and 11 subjects failed to respond at all. Chi Square analysis revealed an association of cabin safety expertise [χ^2 (12, N = 258) = 105.91, $p < .01$] and number of flights [χ^2 (18, N = 258) = 97.96, $p < .01$] with comprehension.

Flotation Device Usage (FD2) Composite Score

Response Type	Comprehension Category	Frequency	Percent	Weight	Comprehension Score
1	Certain	10	3.92	1.00	3.92
	Likely	51	20.00	0.75	15.00
	Arguable	129	50.59	0.50	25.30
	Suspect	53	20.78	0.25	5.20
	Wrong	10	3.92	0.00	0.00
	None	2	8.47	0.00	0.00
	Blank	4	-	-	0.00
	Total	**259**	**100**		**49.4%**

Usable analytical n (255) does not include "blank" responses.

The combined question-specific Type 1 responses were also judged for general understanding of the entire pictogram. Chi-square analysis revealed an association of cabin safety expertise $[\chi^2 (12, N = 258) = 90.57, p < .01]$ and number of flights $[\chi^2 (18, N = 258) = 85.43, p < .01]$ with comprehension. Without the responses from Cabin Safety experts, the composite comprehension score fell to 44.2%.

The Type 0 responses were then categorized for general information relative to overall comprehension of the pictogram.

Flotation Device Usage (FD2) Type 0 Composite Score

Response Type	Comprehension Category	Frequency	Percent	Weight	Comprehension Score
0	Likely	1	25.00	0.50	12.50
	Suspect	3	75.00	0.25	18.75
	Total	**4**	**100**		**31.3%**

Comprehension Category	Typical Type 0 Responses
Arguable	Proper ways to use flotation equipment on board this aircraft. These are step by step procedures.
Suspect	Lift seat cushion for floating, take out floating thing, put it on

An overall comprehension score for the pictogram was derived from combining both the Type 1 composite comprehension score and the comprehension score produced by categorization of the Type 0 responses, which were related to the general essence of the pictorial/pictogram, as opposed to the question-specific content being sought. A weighted average of the Type 1 and Type 0 composite comprehension scores suggests general overall comprehension of about 49.1%.