Hablamos Juntos/SEGD
Universal Symbols in Health Care
Signs That Work

Phase 2
Symbol Design Research Report

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INTRODUCTION

The effectiveness of universal symbols depends on two important attributes: user recognition and comprehension, and consistent use over time. Involvement of relevant users is key to the design of graphical symbols that effectively convey intended messages across language and culture. Consistent use of graphic symbol images increases recognition and thus comprehension value over time. To develop graphic symbols that can be used nationally, by health care facilities serving diverse communities, national user testing is essential. Design schools located around the nation, with their diverse student resources present an opportunity to establish a network of geographically dispersed graphic symbol testing sites.

Four university based design schools committed to advancing evidence-based graphic symbol design formed a consortium to improve the adoptability of the collection of Universal Health Care Symbols (UHCS) and increase the number of graphic symbols in the collection. The consortium was formed in response to a call for participation issued by Hablamos Juntos, a Robert Wood Johnson Foundation initiative to develop practical solutions to language barriers. The work of the consortium is reported in Universal Symbols in Healthcare Workbook In the end, 155 symbols were identified for 22 new referents that could be added to the Universal Healthcare Symbol set. Five new symbols were tested for each of the referents selected. How the symbols were tested, the data gathered, and subsequent analysis and result is the focus of this report.

–Yolanda Partida
Program Director, Hablamos Juntos

RESEARCH QUESTIONS

While the test instrument itself gathered only data about the relative clarity of each of the symbols for the 22 referents, there are additional broader questions imbedded in the research. They include:

> How universal are symbolic messages?

> How well do users understand forms that are extremely simplified and stylized?

> Are there differences in comprehension of symbols depending on one's culture? If so, can these differences be identified and understood by designers?

> Do average users know how to recognize medical procedures in simplified imagery?

> When symbols are successful, what characteristics do they share in common?

> When symbols are unsuccessful, is it possible to identify the reasons for their failures?

METHODOLOGY

Each step of phase 2, from the selection of referents to the testing of users, was conducted with assistance from experts in both healthcare and design.

REFERENT SELECTION

The 19 symbol referents that were selected — in addition to the 28 referents from phase 1 — were based on an in-depth review of the needs of the four innovator facilities selected to develop symbolbased wayfinding programs. The process began with a review of the destination hierarchy of the four facilities dividing them into four basic levels:

- Building Identity
- Building Wings or Units
- Primary Destinations (Departments, Key Functions)
- Support Destinations (Restrooms, Administration, Cafeteria)
- Room Numbers and Addresses

The destinations were placed on a spreadsheet along with a survey of how the innovator facilities reviewed their destination approach. Destinations associated with the first 28 symbols were separated out, and 19 new destinations remained. In addition guidance was developed for the new symbols based on key issues associated with their use in the facility:

a) Referents needed to support four innovator facilities working to implement wayfinding systems with graphic symbols.

b) Referents that support multiple functions in a facility (e.g., Medical Support and Education; administrative functions; nutrition education; library and medical records).

c) Referents that are related to the same basic function but are used in broadly different ways. For example: Mental Health can serve as a clinic, an office, an inpatient facility or a testing location; Dental can be for preventative services, a clinic or a place for surgery; Ophthalmology can be a place for general exams, testing as well as surgery; Ear Nose and Throat can be a location for general examinations, testing or surgery.

d) Referents that cover an umbrella of activities as opposed to one specific activity. For example, Health Services: Can one symbol cover the multiple health services in a clinic or hospital; Alternative Medicine/Complementary Medicine: Can one symbol cover all the services related to alternative or complementary medicine; Inpatient Unit: Can one symbol cover the range of activities involved in a residential hospital?

e) Overarching referents used as a destination in health care facilities in different ways (e.g. Imaging) to determine how best to approach symbol development when there are multiple subcategories of a root referent.

DESIGN PROCESS

In the design phase of the project, four Design schools across the U.S. became engaged in a highly focused effort to develop curricular methods for ongoing graphic symbol design and evaluation, and in doing so, to create new symbols for 18 referents to add to the symbol set; for one referent (imaging), approaches for multi-use symbols and specific symbols were proposed. The new symbol candidates were designed between 2008 and 2009. After the schools had all completed their work, 155 symbols were identified for 22 new referents that could be added to the Universal Healthcare Symbol set.

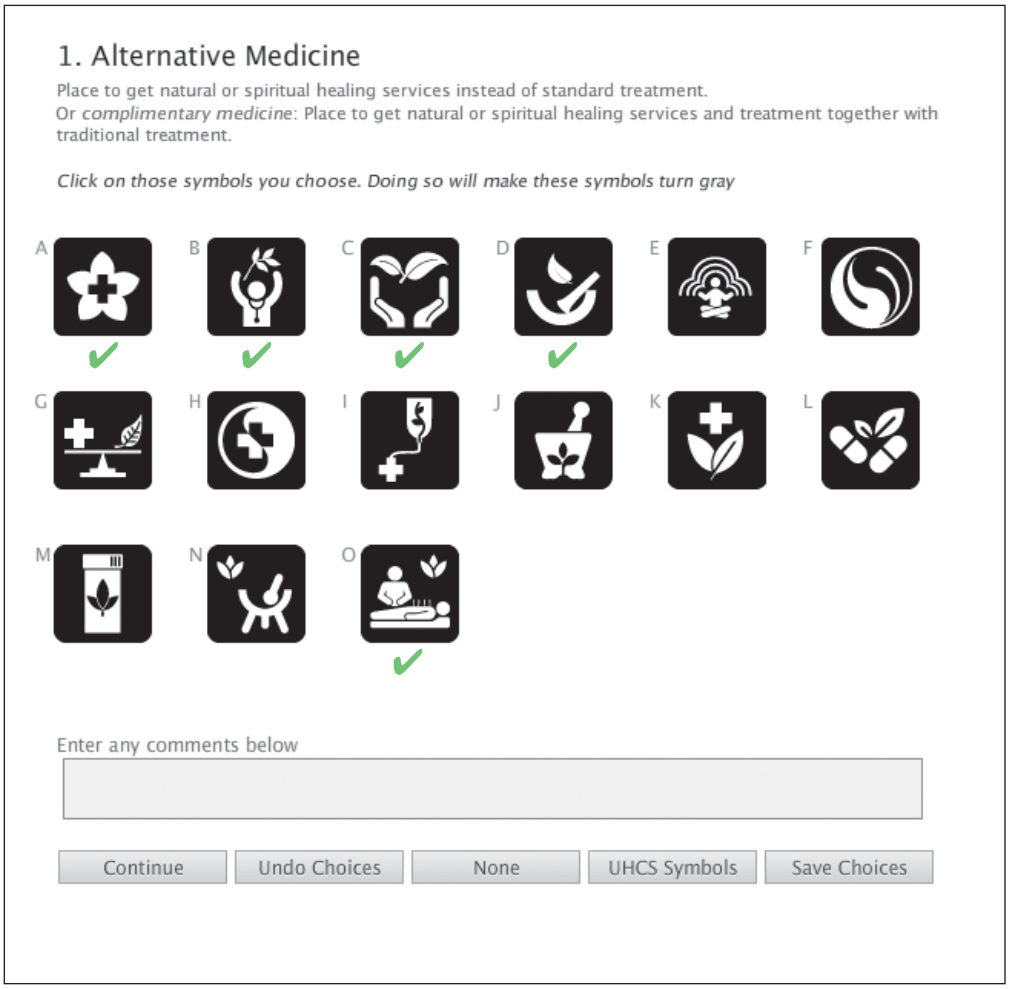
PRELIMINARY DELPHI PANEL TESTING

Given the large quantity of students participating, the design process produced 155 candidate symbols; Clearly, there were more sym¬bol candidates for certain referent categories than were needed for testing. This overabundance was expected, and was planned for; the research team developed a Delphi Panel procedure to narrow the number of symbols down to five images for each referent, which could later be tested with diverse public users.

In preparation for this process, it was necessary for faculty to exercise their professional judgment to remove poorly conceptualized or unclear designs and to select the best choice if some symbols appeared to be essentially the same. This narrowed down the symbol count slightly. During the Delphi Panel procedure, expert reviewers (half graphic designers and half non designers) involved in either Phase 1 or the current phase were invited to participate. Designers on the panel primarily consisted of graphic designers that developed the original UHCS and other technical experts supporting the current project. Non-designers consisted of health professionals and physicians from the current or former UHCS pilot sites and other project advisers and technical experts. A total of 12 designers and 12 non designers evaluated all candidate symbols to select the top five symbols considered best in conveying each referent meaning.

Delphi Panelists used a web link to access an online survey divided into three sections. In the first section, panelists evaluate the effectiveness of symbol candidates designed for 16 referents (topics). Panelists were asked to select symbols they thought was most appropriate for the referent definition. Referent definitions were displayed along with the symbols. Panelists selected, for each referent, up to a maximum of 5 symbols that they believed merited further testing. Or, they could also vote for none as appropriate for each referent.

In the second section, panelists were asked to evaluate generic and specific imaging symbol candidates. For generic imaging, there were 10 candidates. The specific imaging candidates represented MRI-PET and Ultrasound referents.



< Sample page from the online delphi survey.

The third section asked for the evaluation of a design approach known as root/determinant symbols. Panelists were provided a summary and visual examples prior to starting. Displayed were six rows each with three symbols. Panelists were asked to cast a vote by the row with most potential.

STUDY REFERENTS

Administration	In-patient Unit
Anesthesia	Kidney Center
Complementary/Alternative Medicine	Medical Library
Dental	Mental Health
Dermatology	Neurology
Ear, Nose, and Throat	Nutrition
Genetics	Ophthalmology
Health Education	Pathology
Imaging	Respiratory

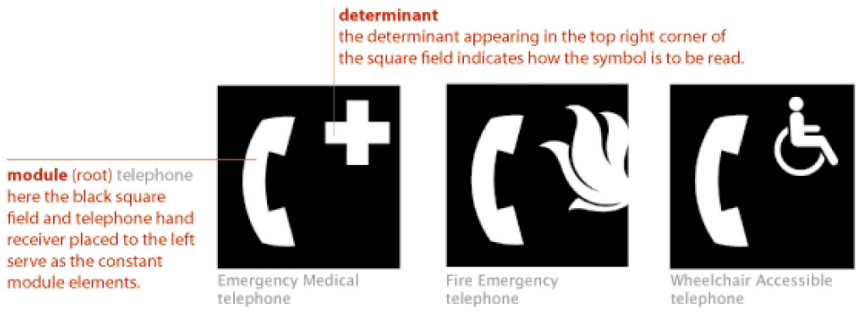
Approximately 155 symbols were created for the 18 referents by design students from university level schools participating in the Design School Consortium. Three of the referents (health services, administrative and ENT) would not be part of the survey, since these referents already had five symbol candidates needed for testing, and therefore needed no further eliminations.

An additional 25 symbols were created for the generic referent Imaging and related functions: MRI, PET, Ultrasound, and Cath Lab.

TESTING A ROOT/DETERMINANT STRATEGY

In the third section of the online survey, panelists were asked to determine the potential of a root/determinant design strategy. Before starting this final section, overview text along with visual examples was provided. The online survey asked the panelists to determine which row of imaging symbols, each using a root/determinant design strategy, had the most communicative and systems potential. Unlike the previous two sections, in which panelists are asked to make selections based on their meaningfulness only, in this section, the systems factor must also be weighed. It now requires panelists to apply foresight and visualize each root/determinant candidate as having capacity for developing even more imaging symbols. Therefore, to clearly distinguish this additional criteria from the preceding single one (meaning), it was decided a separate section would be necessary. By doing this, panelists before beginning, had an opportunity to read a summary about root/determinant approaches and observe visual examples. From a visual display of six rows, each with three symbols demonstrating that student team's root/determinant imaging approach, panelists are asked to vote for the candidate having most potential. The highest vote getter received 10 votes, while the lowest received 2. There were 5 votes separating first and second place.

The online survey would be the only instance where this design strategy, root/determinant, would be tested. Due to the abstract nature of this concept, concerns for participants' confusion led to the decision to exclude this from the survey testing mechanism. It was hoped that testing of these type of symbols might reveal their potential.



< **Excerpt from the root/determinant explanation on the Delphi Panel survey.**

COMPREHENSIBILITY SURVEY TESTING PROCEDURE

Testing was done after approval by each of the school's Institutional Review Boards. All testing was conducted during December 2009 and January 2010.

For consistency with phase 1 of the "Signs That Work" project, the same ISO testing methodology was employed. Yet, three changes were made to the testing display. When participants are asked to assign percentages to each of the five symbol candidates in a referent, they are further instructed that the scores do not all have to equal 100%. To reinforce this, it was decided to remove the outer linear ring. Keeping it gave it the appearance of a pie chart. This was often noted by students when first seeing the ISO testing display. Another visual change was to add dashed lined boxes with a percentage symbol by each symbol candidate. This would provide the respondent with a clear place to write their score and for the eventual tabulators, a way to easily locate these numbers. Finally, rather than leaving the percentages open ended, participants were instructed to enter scores in 5% increments. This would make the survey faster for participants to complete, since they would not having to ponder whether to enter 62% or 63%.

As seen below, the revised ISO 9186-2:2007 Test presents 5 symbol choices for each referent. Survey respondents are asked to rate each of the symbols accord¬ing to the percentage of people they think would understand it to represent the referent. By asking them to identify the symbol(s) that most seem to represent the referent listed in the center, the testing process mimics a real-world wayfinding scenario, where a patient knows they are looking for a specific destination (nutrition, imaging, neurology, etc) and is scanning the environment for a symbol that seems to best communicate that message.

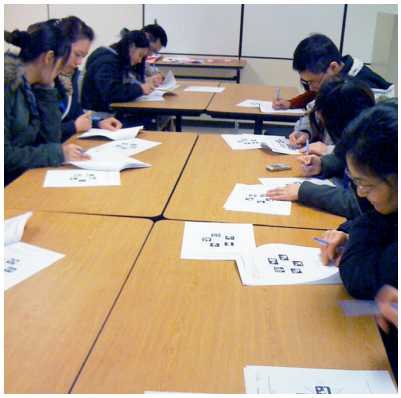
STUDY LOCATION AND PARTICIPANTS

A total of 231 respondents completed the surveys. Each survey con¬tained half of the total set of symbols. Respondents were recruited from 4 language groups: English, Spanish, any Asian language as a group, and other Indo-Europe¬an languages. With 50 respondents from each group (total of 200 subjects), each evaluating half of the symbols, a total of 25 responses per symbol were gathered from each language group (100 responses for each symbol across the three test sites). When data from each of the language groups was compiled, each symbol had been evaluated 100 times.

Test locations included Ames/Des Moines, IA, Kent, OH, and Cincinnati, OH. Each test site was supervised by one of the research faculty from the 3 participating universities: Iowa state University, Kent State University, and University of Cincinnati. At each site, the administration of the surveys was conducted by both faculty and students trained in human subjects testing and trained in administering the survey.

Respondents were excluded if they worked in a medical facility, or were graphic designers. It was determined that these professionals would have a greater than average ability to interpret the messages in the symbols.

Surveyors (students and faculty) were trained using web conference technology. The 90 minute training session covered the scientific nature of conducting surveys, the role of the surveyor, the significance of subject protections and surveyor responsibilities inherent in the survey process, and the import of controls built into the survey process. The purpose of recognition testing, the survey instrument and underlying rationale underlying the protocols established were discussed. Adhering to the testing protocol and the script developed to introduce the survey to potential subjects and to conduct the survey was stressed. Drawing on the experience of Phase I testing, the session also covered likely scenarios surveyors would encounter



Λ

Mason, Ohio: Asian language speakers take the survey at the local high school.

in recruiting subjects and potential questions likely to surface while conducting the test as well as appropriate surveyor responses. In addition, methods and strategies for recruiting subjects from four languages communities were discussed. This included an overview of language groupings (Indo-European and Asian languages), subjects that spoke English and another language and recruiting subjects with limited or no English.

LANGUAGES SPOKEN

A primary goal of the surveys was to determine how effectively the symbols communicated across the many cultures within the U. S. population. To ensure a wide cross-section in the selected respondents, language was used as a variable to stand in for cultural differences. Apart from the English-speaking respondents, the participants were required to have spoken a native language within the defined language group. Many of the respondents had Limited English Proficiency; those that considered themselves bilingual had been in the U.S. for a few years or less, and were therefore still strongly tied to the culture of their country of origin.

Translations were provided for Spanish and Chinese speakers, which explained the purpose of the study and listed each of the referents. Since the Indo-European language group was so varied, the test instruments were not translated for each possible language. On-site translators were able to provide clarification as necessary.

Spanish speaking respondents came from a wide range of Latin American and South American countries. Asian speakers were all from China. Indo-Europeans included those from India, Pakistan, Iran, Russia, Ukraine, Greece, Sri Lanka, Germany and Bulgaria.

English speaking respondents were included to be sure that the selection of a final set of symbols would be successfully interpreted not only by LEP populations, but also by the English-speaking users of U.S. health care facilities.

RESULTS

Results of the survey are presented in Appendix A. The test results are summarized here.

HIGH SCORING SYMBOLS

Of the 22 referents tested, only five had symbols that scored at the median of 87 or above which is suggested for acceptability by the ISO standards. Symbols that scored at 90 include those for In-patient Services, Neurology, Respiration, and Imaging (2 symbols); Dental had a symbol scoring at 98, and another at 90.

Eleven symbols scored at 80; these included symbols for Anesthesia, Health Education, Kidney, Medical Library, Ophthalmology (3 symbols), Ultrasound (2 symbols), MRI/PET, and Respiratory. While these numbers do not achieve the required score using the ISO standard, a score of 80 would equate to a 4-out-of-5 score if a more common Likert Scale had been used. In that case they would have been rated as "clear" if the Likert Scale ranged from "very unclear" to "very clear".

LOW SCORING SYMBOLS

The lowest 'top' score for any referent was for Mental Health, with a top symbol score of 60. This score is not surprising, given the difficulty in communicating the invisible and sensitive issues of mental health.

FINDINGS

ANALYSIS OF HIGH SCORING SYMBOLS

For graphic designers, assessing the results of evidence based testing is new territory. To seek out opinions from their intended audience/user in a scientific manner would have seemed ridiculous years ago. While a test of this scope cannot establish any universal recommendations for symbol design, it is useful to review the findings to see if any patterns or themes exist. When examining and comparing those symbols receiving the highest scores, the way things look remains important in determining what was learned. In several referents, two or three symbols receiving the higher scores would contain the same image content and components. The only difference might be a different object, slightly different style or being illegible. Also, when comparing the higher scoring symbols to the lower ones within the referent, more deductions are made. These noted visual subtleties from the symbol comparisons allowed some conclusions to be made in the overall analysis.

While a test of this scope cannot establish any universal recommendations or definitive conclusions for symbol design, it nonetheless provides insightful results for designers. Without further research,

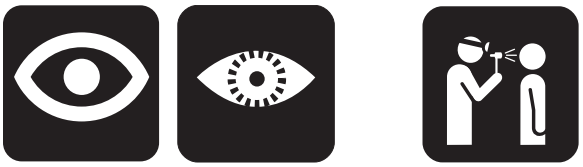
we cannot know why one kind of image is more or less clear. Still, identifying these patterns will be useful for symbol designers to consider in future attempts to reach a universal audience.

The highest scoring symbols tend to fall into two categories: iconic or narrative.

ICONIC

The iconic approach is evident in high scoring symbols such as those shown below for Dental (98), Imaging (90), Neurology (70), Ultra-sound (80) and others. These icons show simple depictions of how the procedure or body part would look, without adding a storytelling component. An icon embodies the characteristics of boldness and simplicity of form that is commonly equated in practice with more legible, and therefore more successful symbol design.

Ophthalmology is an interesting example, with the highest scoring symbols shown below, having either simple icons (80, 80). or a strong complex narrative (80).



NARRATIVE

In reviewing the test results, there appears to be a preference for more complex visual storytelling (or narrative), with a maximum number of visual elements that can be integrated into a simple frame or "scene." This is evident in the high scoring symbol for Inpatient Services (90), where the inclusion of the crescent moon provides a narrative of an overnight in-patient hospital stay. The narrative approach is also evident in the most successful symbols for Respiration (90), Medical Library (80), MRI-PET (80), Health Education (80) and others.

COMPARING SUCCESSFUL AND LESS SUCCESSFUL SYMBOLS:

CONTEXT

The inclusion of elements that provide clear references to context can contribute to understanding. For the two medical library symbols, both have human figures in the action of reading. Yet the symbol that includes a stack of books sitting on a shelf behind the figure scored better of the two. This could support the assumed association for a library having many books and sitting shelves. It's possible that the traditional Hermes (staff) medical symbol (60) may have been perceived instead as a Christian cross due to the smaller scale presentation.

The survey results seem to suggest that the inclusion of context is only helpful if the elements added are clear and unambiguous. This can be seen in comparing the successful and unsuccessful symbols for Inpatient services: while they all include a similar quantity of elements, users were able to understand the moon as representing night, while the more ambiguous wall calendar and privacy curtain did not seem to convey an overnight stay. These results may suggest that when designing symbols, it is important to determine the most defining aspect to the activity, procedure or event.

While not specifically tested in this study, it is known that complexity in a graphic symbol may be a detriment to legibility in the environment, where the viewer is moving and viewing from a distance, and engaged in other activities. So, while narrative and contextual details may provide assistance in establshing meaning, they should be introduced with care.

DISTINCTIVE SHAPES

There were several cases found in the survey results where two to three symbols for the same referent had nearly identical image content and similar arrangements within the square field. This allowed for direct visual comparisons and observations.

For the two in-patient symbols shown, the left one, which scored the highest (90), uses a crescent moon as opposed to the other symbol's wall clock (75). The white crescent seems to provide a more distinctive shape as compared to the round clock. In the symbol with the clock, possibly there are many other round shapes: the wall clock, nurse's cap, and the circular head shapes for patient and nurse. According to perception principles, similar forms tend to group.

These results suggest that when selecting image content for intended symbols, designers should consider visual elements with distinctive shapes, contours and profiles—especially when arranged with other visual elements in the same field. This seems to provide greater legibility and memorability.

LOCATING AILMENTS/ORGANS ON HUMAN BODY

Showing ailments or relevant organs directly located on the human body seems to provide comprehension value; this can be seen in the high scoring symbols for Kidney (80), Respiratory (90), and Neurology (90).

HUMAN FIGURE: LITERAL VERSUS ABSTRACT

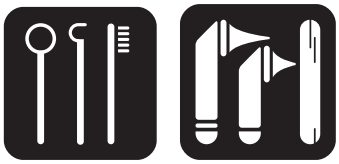
When comparing the highest scoring respiratory symbol (90) to the second highest (80), it can be seen that the more literal rather than more abstract one was preferable. The left symbol has more features compared to the right, showing neck, nose and a more normal head shape. The ENT symbol showing detached ear and nose, with extremely simple head scored poorly (10). This is consistent with classroom observation and discussions, where it was decided that certain medical referents (e.g., ENT) require more detail and visual information.

WHAT WE CAN LEARN FROM LOW SCORING SYMBOLS

Some recurring themes appear when evaluating the low scoring symbols for each referent:

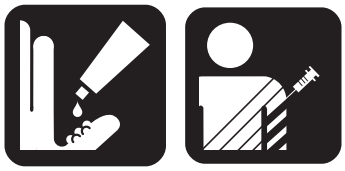
OBJECTS & TOOLS

Objects, devices and tools depicted by themselves without human figures did not score well. Even when directly related to their medical referent or procedure, such as the dental symbol below (included only on Delphi Panel) and the ENT tools (13) panelists and survey respondents did not favor them. This suggests that using objects, devices and tools (especially hand tools) without human figures does not assure user comprehension.



CROPPED FORMS

Images that include cropped forms did not score well; possibly the result of users not being able to understand what these shapes mean, since they don't see the larger form from which they are taken. For example, the segment of a hand shown with lotion (48) and the cropped person with injection needle (25) were not rated as clear messages.



DEPICTION OF PROCESSES

Users had a difficult time with symbols that showed depictions of a medical process. For example, they did not respond well to the depiction of the 'cleansing' process on the kidney symbols (20), or the depiction of anesthesia progressively penetrating into the body (25). Also unclear was the MRI symbol that attempts to depict the rotating process of the machinery as it goes around the body during the MRI exam (20). The image showing penetration of magnetic waves across the body also seems to have been too confusing (20).

METAPHORS

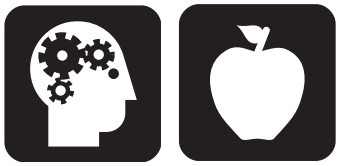
Symbols that used metaphoric concepts did not score well. It seems that visual metaphors—where one analagous concept is substituted for another—present comprehension challenges. This can be seen in the low scores of the symbols that included the leaf as a metaphor for natural healing (30, 40). Also unsuccessful were the 'sunny day' metaphor for mental health (15), and references to the 'fractured mind' (5). The family tree metaphor used for genetics did not come across well (50), and the visual pun of apple as medical person was also unclear (40). Interestingly, however, the most successful mental health symbol was a metaphor; that symbol shows gears inside the head to represent the workings of the mind (60). This metaphor probably was a bit clearer due to its frequency of use in other visual media; gears are often used to represent the mind.

AMBIGUOUS ELEMENTS

Symbols which included forms that could appear to represent something other than their intended message did not score well. This can be seen in the examples of the book with cross (30), which may be confused with a bible, and the simple apple (20) which might seem to connote a cafeteria. Likewise, the pill bottle (15) might be interpreted as a pharmacy, and the computer screen (20) might represent any staff person's office, or possibly even a TV screen. This also occurs when a computer screen is used for the pathology lab (10); the computer might not be as unique a tool as the microscope for this referent. In the neurology symbol that scored lowest (20), the nervous system might be confused with the circulatory system within the human body.

SYMBOLIC (LEARNED) FORMS

A symbol that often did not score highly was one that was neither narrative nor icon. This is in the truest sense of the word a "symbol" as defined in semiotic terms: the interpreter understands the meaning of such a symbol through previous knowledge and experience. This can be clearly seen in the highest scoring symbol for Mental Health (60), which is a profile of the head with gears inside. While it was the high scorer for this referent, it is the lowest of all 'high scoring' results for any referent category. Another example is the apple for nutrition (20.) These observations are in keeping with the results of testing from the initial set of 28 symbols, where symbols with presumably 'learned' meanings failed to test as well as expected.



During the design phase of the project, it was determined that the inclusion of some 'learned' messages would be useful for data collection. Given the cross-cultural intention of the symbol set, it is important for the designers to see if their assumptions of universality through learned meanings was accurate, or if some of these learned messages are limited to one culture. The test results do bring such assumptions of universality into question; problems occurred in many instances when the designers assumed the users' familiar¬ity with existing visual codes that have been learned by many to represent a particular concept.

Meggs, Philip. *Type and Image*, p. 8.

For example, Americans have learned that the apple represents education; the education symbols that use it did not, however, communicate clearly (30, 40) to the cross-cultural mix of survey respondents. The mortar + pestle is assumed to have universal meaning as a reference to pharmaceuticals, but its low score here (40) suggests otherwise.

ORIENTATION OF THE BODY

Symbols that showed an unexpected orientation of the human body did not score well. For example, the walking patient for inpatient services (15) seems at odds with the stereotypical image of a hospital patient, who is often perceived as lying down. The vertical orientation of this figure may be confusing the message. Similarly, the Cath Lab image that portrays a vertical body was not clear to users (50); they likely assumed that the Cath machinery would require a person to lie down.

SURVEY RESPONDENTS VS. ACTUAL PATIENTS

Actual hospital patients may actually have more success interpreting these symbols than did our survey respondents, who have no particular knowledge of medical procedures and diseases.

While it would be nearly impossible to find survey volunteers who also had experience with each of the relevant diseases, the use of 'non-patients' means they lack some of the basic knowledge that would help in interpreting a symbol. They often don't know the techniques, equipment or the specific problems associated with each disease or destination. For example: kidney disease patients know that kidneys perform a cleansing, circulatory function, while the average person might not recall what kidneys do. This makes it likely that the test respondent will only understand the most iconic symbols (those that only show a pair of kidneys), while the actual kidney patient would recognize the concepts of flow and purification.

This is the case with many of the imaging procedures as well: an actual patient arriving for an imaging procedure is likely to know the shape of the MRI machine, the Cath Lab equipment, and what the ultrasound screen looks like. Given the availability of such information today, it's likely that a patient will have read or seen something about their upcoming procedure. The survey respondents may not know any of these details, so it is hard to know what knowledge they are using to evaluate the imaging symbols. While we cannot measure the difference between patient and non-patient interpretations, it is a reason¬able assumption to expect that actual patients will have an easier time decoding the symbol that refers to their medical destination.

As recognized in the original study, some referents did not reach the 87 threshold, but still received scores that suggest a good level of clarity. With exposure over time, many believe that promising symbols such as these can be learned and assimilated into a way-finding vocabulary.

IMPLICATIONS FOR FURTHER RESEARCH

If an opportunity arose for future symbol research, additional testing methods might be employed, offering the possibility to learn more about the following:

Additional testing methods could determine the respondents' per¬sonal preferences, and perhaps why they do or don't prefer a symbol. For example, they may have found a symbol easy to understand, but distasteful or insulting. This information would be immensely useful for future symbol design projects.

A different test could help us to understand what they might have been confused by in each symbol. If a symbol ranked poorly in the current test, we don't know if it was because they thought the patient looked dead, or if they thought the patient would be standing up during the procedure, legibility issues, or if they confused a piece of diagnostic machinery with a chair, table, desk, etc. Since the test instrument used (ISO 9186-2: 2007) is intended to rate only the clarity of each message, we don't know what for certain what objects or approaches confused them.

As this symbol set expands, it becomes more and more important to know how well users are able to distinguish the symbols for similar referents (radiology vs. MRI). A testing methodology would need to be devised to help determine adequate distinctions from one referent symbol to another.

Further research needs to be undertaken regarding the root/determinant symbol strategy. Because the testing device used in the surveys was developed only for estimating the comprehensibility of symbol candidates to an intended referent, inserting root/determinant approaches would have risked confusion among participants. Due to time and financial constraints, searching for or developing a separate testing device for root/determinant symbols became impossible. Instead, they were integrated within the other relevant medical referents, in hopes the survey's results would show some indication to their potential. And there were some indications. Two root/determinant symbols (hand holding film and head profile) received high scores (90, 90). Whether an appropriate testing device for this strategy does already exist somewhere remains to be found. Or, if not, one definitely needs to be developed for true evidence-based testing. Hospital environments are complex, and relying on single symbols alone may prove limiting for implementation and ineffective for the public user.

MOVING FORWARD TO A FINAL SYMBOL SET

It is at this stage, when no more testing is possible, the project team must now rely on a combination of both empirical and inherent knowledge. While the test results are certainly beneficial, they are limited to comprehension, and do not consider how well each symbol fits the existing symbol system. For example, a symbol might test well, but be too different from the rest of the symbol set to function well in the series. A few of the finalist symbols may be too far away from the existing symbols to conform regardless of what refinements might be done. This is because the survey participants are only asked about their opinions on what is the most appropriate symbol candidate to represent a certain referent. They are deciding on a single symbol. The designer considers all the symbols and how each needs to work within an interrelated system. These inconsistencies will be resolved at the final refinement stage, where decisions will be made about which of the high scoring symbols for each referent best fit the overall vocabulary of the system. Much like a physician, the designer must carefully study the evidence-based results, but then must supplement this with inherent knowledge in order to make a diagnosis.

DESIGN OF THE FINAL SYMBOL SET

Mies Hora from Ultimate Symbol was engaged as a symbol design consultant for the Universal Symbols in Healthcare - Hablamos Juntos/ SEGD project. He was responsible for the final design of the symbols. Working closely with the academic research teams, the project director Yolanda Partida, Craig Berger of the SEGD, and his design associate Christopher O'Hara, Mies presented refinements, enhancements and alternate symbol elements and concepts for the project members to review, before consolidating the consensus decisions in the final symbol artwork.

In addition, Mies revisited the original set of 28 health care symbols developed during the first Hablamos Juntos/SEGD collaboration ompleted in 2006. Using the new set of 22 symbols as a guide, Mies refined the older set for consistency in their overall design, including subject-to-field size considerations, line weights, element styling, etc. In this way, both sets of symbols were finally integrated into one comprehensive 50 symbol system that adheres to internationally recognized symbol design standards. There are also four alternate Imaging symbols.

BIBLIOGRAPHY

Abdullah, Rayan. *Pictograms, Icons and Signs*. Thames & Hudson; 2006

Ackerman, Marion, and Rathgeber, Pirkko. *Pictograms: The Loneliness of Signs*. National Book Network. 2007.

Asa Berger, Arthur. *Signs in Contemporary Culture: an Introduction to Semiotics*. Sheffield Publishing, Salem, Wisconsin. 1999.

Caplin, Steve. *Icon Design: Graphic Icons in Computer interface Design*. Watson Gutpill, New York. 2001.

Cowgill, Jamie, et al. *Symbol Usage in Health Care Settings for People with Limited English Proficiency*. Hablamos Juntos. 2005.

Crow, David. *Visible Signs*. AVA Publishing. Lausanne, Switzerland. 2003.

Dreyfuss, H. *Symbol Sourcebook: An Authoritative Guide to International Symbols*.1984. Van Nostrand, Reinhold, New York.

Frutiger, Adrian. *Signs & Symbols: Their Design & Meaning*. Van Nostrand Reinhold, New York. 1989.

Evamy, Michael. *World Without Words*. Watson Guptill Publications. 2003.

Hall, Sean. *This Means This, This Means That: a User's Guide to Semiotics*. Lawrence King Books. London. 2007.

Hirsch, E.D. *Cultural Literacy*. Vintage Books, New York. 1988.

Holmes, Nigel. *Wordless Diagrams*. Bloomsbury Publishing. New York. 2005.

Hora, Mies. *Official Signs & Icons 2*. Ultimate Symbol Inc. 2005.

ISO 9186-1:2007. *Part 1: Methods for Testing Comprehensibility*. International Organization for Standardization; 2007.

ISO 9186-2:2008. *Part 2: Methods for Testing Perceptual Qualities*. International Organization for Standardization; 2007.

Jones, S., 1978. *Symbolic representation of abstract concepts*. Ergonomics 21 4, pp. 573–577.

Macnab, Maggie. *Decoding Design: Understanding and Using Symbols in Visual Communication*. How Books, Cincinnati, OH. 2008.

Meggs, Philip. *Type and Image: The Language of Graphic Design*. John Wiley and Sons, Hoboken, NJ. 1989.

Mollerup, Per. *Wayshowing: A Guide to Environmental Signage Principles & Practices*. Lars Müeller Publishers, Baden, Germany. 2005.

Morgan, John, and Welton, Peter. *See What I Mean: an Introduction to Visual Communication*. Edward Arnold Publishers. 1986.

Pavio, A., Rogers, T.B. and Smythe, P.C., 1968. Why are pictures easier to recall than words? Psychonomic Science 11 4, pp. 137–138.

Pierce, Todd. *International Pictograms Standard*. Watson Guptill Publications. 1997.

Standing, L., Conezio, J. and Haber, N., 1970. Perception and memory of pictures: single trial learning of 2500 visual stimuli. Psychonomic Science 19, pp. 73–74.

Steiner, Henry, and Haas Ken, *Cross-Cultural Design: Communicating in the Global Marketplace,* Thames & Hudson. 1995.

Vukelich, M. and Whitaker, L.A., 1993. The effects of context on the comprehension of graphic symbols. In Proc. Human Factors Ergonomics Soc. 37th Annual Meeting, pp. 511–515.

Yew, Wei. *The Olympic Image: The First 100 Years*. Books Nippan. 1997.

APPENDIX A: SURVEY RESULTS

Test results are presented both as composite scores as well as scores by the English speaking group. Median scores (composite) are listed in red underneath each symbol; English speaker scores are listed in gray. The highest scoring symbol(s) for each referent is shown in black.

The final symbol set *is available for download at www.hablamosjuntos.org.org.*

Do not reproduce the symbols shown here; they are not the final set.

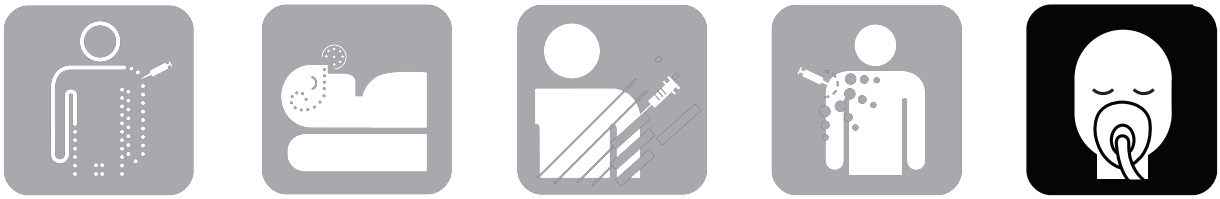
ADMINISTRATION

40	70	50	30	20
17.5	45	60	25	25

ALTERNATIVE / CONTEMPORARY CARE

40	75	30	40	15
25	70	40	17.5	15

ANESTHESIA



50	43	25	30	80
25	37.5	20	20	80

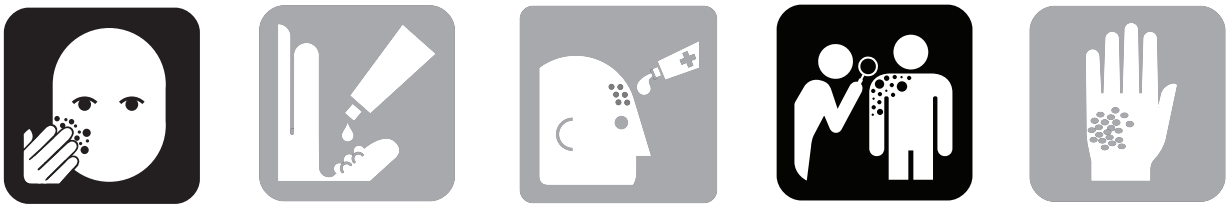
CATH LAB

75	50	75	30	33
75	50	70	20	22.5

DENTAL

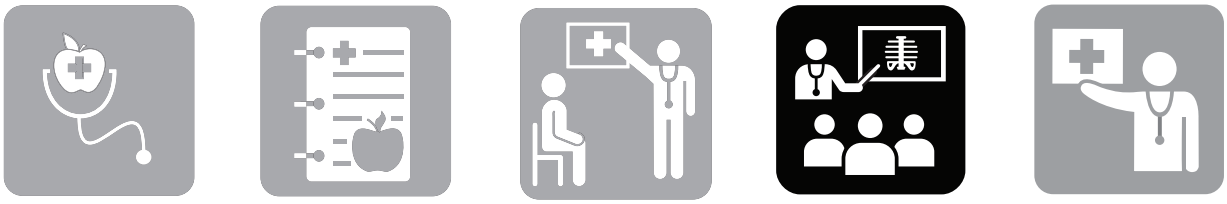
98	90	80	75	80
100	90	75	55	82.5

DERMATOLOGY



70	48	50	70	50
60	50	62.5	65	42.5

HEALTH EDUCATION

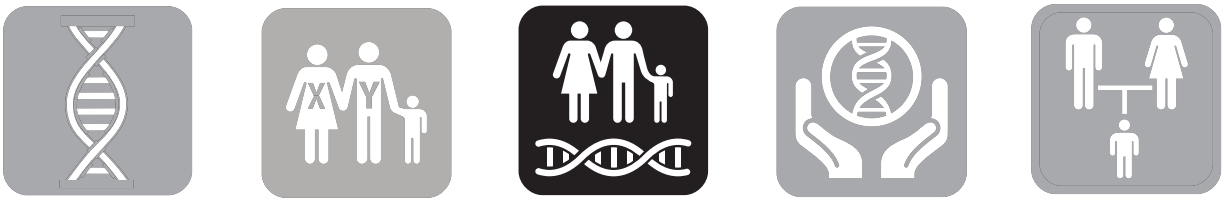


40	30	75	80	50
20	27.5	70	80	50

EAR, NOSE, AND THROAT

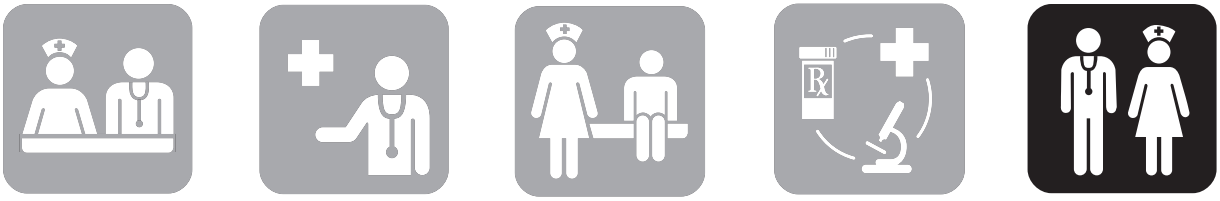
63	13	50	70	10
50	15	55	75	0

GENETICS



50	70	75	45	50
20	60	65	20	55

HEALTH SERVICES



70	60	63	40	73
50	50	50	27.5	60

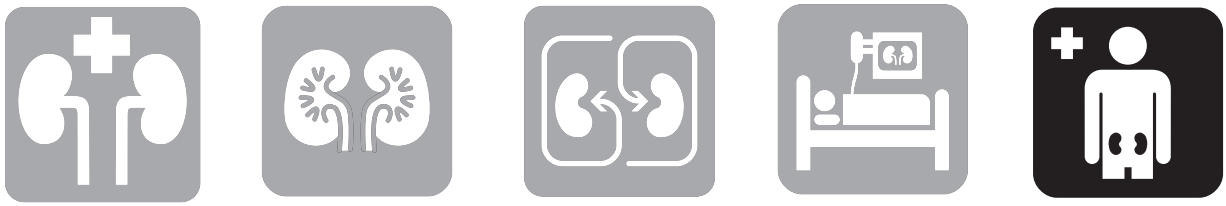
IMAGING

50	20	90	60	90
55	10	90	50	75

IN-PATIENT

55	40	75	15	90
65	25	40	5	85

KIDNEY CENTER



70	60	20	50	80
50	35	15	50	65

MEDICAL LIBRARY

30	80	40	60	70
20	65	60	75	40

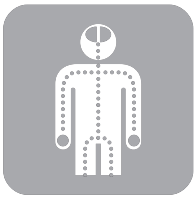
MENTAL HEALTH

15	5	55	60	10
10	0	80	45	10

MRI-PET

80	40	50	20	75
80	70	75	25	65

NEUROLOGY



50
40

60
45

50
50

90
85

50
25

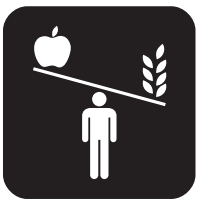
NUTRITION

50
25

20
25

60
65

70
70



70
60

OPHTHALMOLOGY

80
85

60
75

80
80

80
75

60
60

PATHOLOGY

75
50

60
50

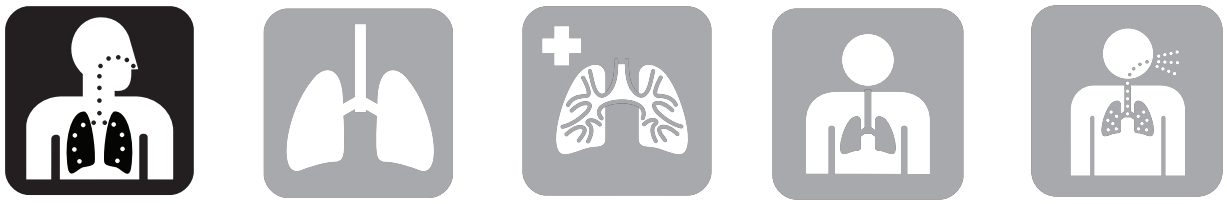
75
70

10
10

60
30

NOT the final symbol set: do not reproduce

RESPIRATORY



90	65	70	60	80
85	50	50	70	80

ULTRASOUND

70	80	80	50	70
60	80	50	30	80