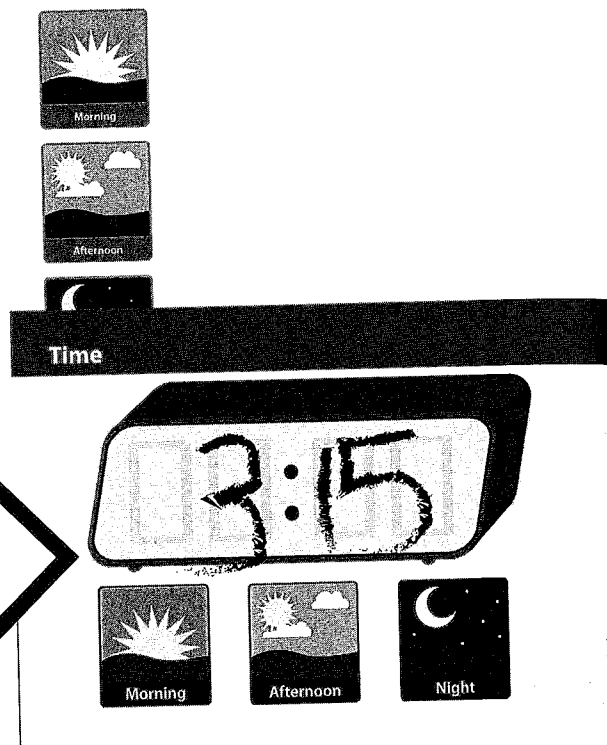
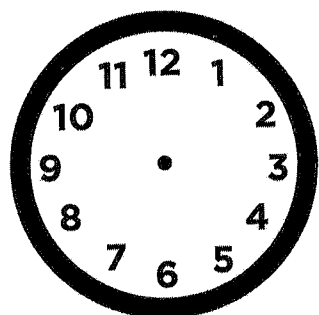


Time icon
for communication
during emergency

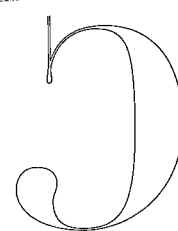
ineffective



effective



with user writing -
more effective



Using Icons to Overcome Communication Barriers During Emergencies: *a case study of the Show Me interactive tools*

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ABSTRACT

This case study reviews the development of three icon-based tools designed to help workers and volunteers during an emergency communicate with people who have communication challenges, such as limited English proficiency, deafness or hearing impairments, and cognitive delays. Using the classic human figure icons designed by the American Institute of Graphic Arts (AIGA) for the U.S. Department of Transportation (DOT) as a basis, we developed over 250 new icons for the tools, a dry erase booklet and two mobile applications for Apple and Android devices. We outline the challenges we faced researching, testing, and developing the icons. We also explore interactivity, animation, and the grouping of icons and suggest ways to push icon design in new directions. This project was a partnership between CommunicateHealth, a health communication company in Northampton, MA, and the Massachusetts Department of Public Health (MDPH), Office of Preparedness and Emergency Management.

KEYWORDS

Icons, public health, emergency preparedness, nonverbal communication, symbols

It will come as no surprise to designers, or anyone reading a design journal, that people like pictures. But imagery, like photography and iconography, has proved to be an especially powerful tool in communicating messages about health. As Houts et al have shown, imagery in health materials helps people — particularly people with low health literacy — understand and remember information (2006). Given that nine out of ten adults in the United States struggle with complex health information, health communicators have come to recognize that imagery may be more than just a nice adornment to their fact sheets or websites, but an ethical imperative (Kutner et al, 2006).

Designers working on health promotion naturally want to use imagery that conveys information as clearly and quickly as possible, so users can grasp essential messages about their health at a glance. For this reason, designers often gravitate toward one of the best-known and ubiquitous forms of iconography: the human figure icons designed by American Institute of Graphic Arts (AIGA) for the U.S. Department of Transportation (DOT) in the 1970s, which were intended as a standard icon system for global communication (Zender, 2006).

Derived from the principles of Otto Neurath's work in the 1920s to create a system of universally understood icons, the AIGA/DOT icons became known as the "Helvetica of pictograms" because of their visual cohesion and widespread use. Familiar to virtually anyone who's pushed open the door to a public restroom throughout the world, these icons became a model for countless other systems. In particular, designers have used and adapted the male symbol, which Lupton later dubbed "Helvetica Man" (1996).

What's most striking about Helvetica man — and the overall approach to icon design — might be his endurance. As Zender and others have observed, these icons have gone essentially unchanged for decades. And in the 21st century, mobile apps have opened up a new venue for these classic icons. A glance at the App Store or Google Play Marketplace will show hundreds of apps — for fitness, health, medical, and countless other uses — that have pressed the Helvetica man into service for an ever-expanding set of duties (Zender, 2006).

But designers make a mistake if they incorporate these familiar icons into their work reflexively, assuming that their popular use necessarily means that people understand what they're meant to convey. In fact, studies have found that people often fail to understand similar icons in the way their designers intended.

Fascara discusses how designers may passively assume a graphic or icon has an obvious meaning — because of their own personal or cultural context — when it might be baffling to other audiences (2004). He points to the work of Easterby, Graydon, and Zwaga with the International Standards Organization (ISO) as an example; their testing of graphic symbols with users found that these symbols "normally perform

much below the designers' expectations." And despite the ongoing work of researchers and groups like ISO to design and test graphic symbols, this gulf between a designer's intended meaning and a user's actual understanding is an enduring problem. Zender cites an international study of medical icons aimed to supplement the AIGA/DOT system that found that only eight out of 54 new medical icons — carefully designed to cross language and cultural barriers — were understood by a percentage of subjects deemed acceptable by the ISO and American National Standards Institute (85%); with Tanzanian subjects, only three icons met that threshold (Zender and Mejía, 2013).

Research showing problems with icon comprehension doesn't negate their value as a communication tool. From the perspective of design, building on the AIGA/DOT icons has obvious advantages — they're immediately familiar to most audiences and they're in the public domain. But the point is that designers can't simply incorporate these icons into new medical and health projects and assume that users will automatically understand them. Designers need to consider how an icon's context will affect a user's understanding (McDougall and Martin, 2004), and how design methods that incorporate user feedback will create a more effective product (Salman, 2012).

In this case study, we discuss the challenges we faced in developing new icons — building on the classic AIGA/DOT set — for the three "Show Me" public health communication tools for emergencies developed by CommunicateHealth, a health communications company based in Northampton, Massachusetts, on behalf of the Office of Preparedness and Emergency Management of the Massachusetts Department of Public Health (MDPH).

During the course of development, research, and testing, our team found how the context of icons could radically affect their meaning to users. After describing the project, we focus on three specific challenges we faced during icon development, testing, and revision that illustrate how we pushed the limits of current icon use and design — and how interactivity, animation, and grouping can help simple icons convey complex messages.

PROJECT BACKGROUND

In 2011, MDPH contracted CommunicateHealth to work on a project to help aid communication during emergencies and disasters. During an emergency — like an earthquake or chemical spill — volunteers and emergency response workers need to communicate clearly and efficiently with people who need help. But MDPH needed new tools to help with a serious public health problem: the difficulty of communicating during these disasters with people who have communication challenges, such as limited or no English proficiency, deafness or difficulty hearing, and cognitive delays.

Communication barriers are amplified during an emergency. Members of the public are likely to be distressed, confused, or angry. Some may have been involved in the disaster, and could be traumatized, injured, or suffer from temporary hearing loss or disorientation. According to the Centers for Disease Control and Prevention, sustained emotional distress can “make community members less motivated and less able to take actions that could help themselves.” (USHSS, 2014) In addition, staff and volunteers are also likely to be stressed and overworked; they may have limited technical aptitude and not speak languages besides English. Easy-to-use tools to facilitate clear, efficient conversation between staff and volunteers and members of the public would save time, prevent misunderstandings, and increase trust.

THE SHOW ME TOOLS

The CommunicateHealth design team had a broad mandate from MDPH when developing the first Show Me tool. We needed to create a tool that would improve communication, but the client had no specific requirements about the form the tool would take.

During our initial design scan, we found many tools — such as mobile apps — for first responders during an emergency, but none that were intended to supplement communication during emergencies. Our team knew that we would have to create a new approach to fill the gap.

Over the next 3 years CommunicateHealth team produced three separate tools:

Show Me booklet.

Our first product was a spiral-bound, laminated, dry erase booklet for use in emergency shelters.

Show Me mobile app.

The second tool, an app for mobile phones and tablets, expanded on the content of the booklet. We designed it for volunteers and staff who are either working in a specific location (an emergency shelter or emergency dispensing site) or going door-to-door warning people to evacuate or shelter in place (stay at home).

Show Me FAC mobile app.

We tailored the third app for staff and volunteers at family assistance centers (FACs), where family may gather looking for loved ones after a mass casualty event (MCE), such as a plane crash. We also added features specifically for people with limited or no English proficiency.

We developed the booklet first and, after its successful adoption — over 1,300 copies were distributed in the first 3 months

of printing — then created the mobile apps, which are both available for free on iTunes and the Google Play Marketplace.

ICON-BASED COMMUNICATION

Though the tools were developed in three phases and took different forms — one as a booklet and two as mobile apps — they all hinged on icons, which served as a common language for users.

After conducting an exhaustive literature review and exploring various approaches, the CommunicateHealth team settled on using icons, based on the body of evidence showing they can be an effective way of communicating health information to the widest possible audience. For instance, research conducted by Hablamos Juntos with support from the Robert Wood Johnson Foundation found distinct advantages to using universal symbols (based on the AIGA/DOT set) in hospitals instead of written signs.

..... In a trial of 86 participants, only one person preferred the signs with words to the symbols

..... In a trial of 85 participants, 70 said that symbols made it easier to find where they were trying to go

..... Testing found that people in hospitals walked one foot per second faster when guided by symbols instead of words (Hablamos Juntos, 2005)

We also found evidence that an icon-based approach would benefit one of our specific audiences, people with communication challenges. Studies of individuals requiring additional assistance (IRAA) during emergencies found that pictures, icons, and symbols enhanced understanding and reinforced written or spoken language (Faux, 2004; Jonsson et al, 2011).

While icons have traditionally been a form of one-way communication — a simple instruction to the user — we wanted to use them for two-way communication, a common language for staff or volunteers during a disaster and people with communication challenges. So the icons needed to work for two different audiences. Staff and volunteers might need to tell people to leave their homes or where to get bedding or food in a shelter or FAC. People with communication challenges might need a translator, or want to describe a missing person, or need medical assistance.

With an icon-based form of communication, people with communication challenges could point to icons in the book or on the app — showing the staff member or volunteer exactly what they wanted. They could then hand it back to a volunteer, who could do the

same, allowing for a real conversation.

In adopting this approach, we drew from the principles of augmentative and alternative communication (AAC) systems. The American Speech-Language-Hearing Association website defines AAC as “including all forms of communication (other than oral speech) that are used to express thoughts, needs, wants, and ideas.” Aided communication tools — such as picture and symbol communication boards — help people express themselves beyond their use of sign language, body language, or gestures (Light and McNaughton, 2013).

METHODS

We followed the user-centered design (UCD) process — a method for developing materials that involves end-users as co-creators in every step of development. Rather than finishing a product and then testing it, we test at each stage of development and revise based on the results. Research for each tool included staff or volunteers as well as members of the public with communication challenges, such as limited English proficiency, deafness or hearing impairments, and cognitive disabilities.

At the start of the Show Me booklet project, we conducted in-depth interviews (N=9) with professionals to provide a qualitative base for the project in assessing communication challenges during an emergency. Focus groups with public health professionals (N=12) and people with communication challenges (N=22) helped assess existing types of communication tools and identify the communication needs our tool would address.

Based on this foundation, we developed paper prototypes of the tool that we tested with users in a second set of focus groups (N=9) and informal interviews (N=7). After another round of feedback and revision, we tested icons in one-on-one usability tests (N=6).

Lastly, to assess the overall usability of the tool, we conducted 6 dyadic usability tests (N=12) — in each one, we paired a public health professional with a person who had communication challenges. This somewhat unusual method of testing was crucial, since it allowed the team to see how well the icons really worked as a common language for communication.

When we started developing the mobile applications, our research followed a similar trajectory, although instead of testing paper prototypes we tested wireframes and eventually the app itself on Apple and Android devices. The Show Me for Emergencies app research included in-depth-interviews (N=8), icon testing in one-on-one usability sessions, including card sorting (N=6), app prototype usability testing with remote users via a desktop simulator (n=3), and dyadic testing on mobile devices (n=3).

The Show Me for Emergencies FAC app research included in-depth interviews (N=7), icon testing in one-on-one usability sessions (N=9) with a particular focus on limited or no English proficiency, app prototype usability testing with remote users via interactive wireframes (N=5), a second round of icon testing in one-on-one usability sessions (N=3), and on-device usability testing (N=3).

CHALLENGES AND SOLUTIONS IN ICON DESIGN

While our design team settled on the basic style of the classic AIGA/DOT icons, the project had very specialized requirements. The large number of messages we had to convey were specific to the setting of an emergency and also needed to work as a form of two-way communication. We eventually developed over 250 new icons for the Show Me tools. Our task was made easier by the accommodating three-year timeline. We created an initial set of 65 icons for the first tool (the booklet), built on that initial set when creating additional icons for the next tool (the Show Me app), and then added more for the final tool (the Show Me FAC app). The iterative design and testing process helped us adjust and refine the icons as we went. We also designed the icons in groups so we could use symbols more than once; for instance, we reused elements like the “prohibition sign” along with different foods to signify specific food allergies. This approach helped create cohesion that would help users understand the icons in context while also simplifying the challenge of designing such a large number of icons.

Designing icons often involves stripping a concept down and expressing it as simply as possible so people can understand the message at a glance. However, as we have discussed above, this process — which Neurath called reduction (Lupton, 1986) — does not ensure an effective icon. Often, simplifying an idea, action, or message can make an icon so generic and bland that it loses meaning — or takes on a host of possible meanings that the designers never intended. Throughout the testing process, we were often surprised by the unexpected ways that participants interpreted our icons. But thanks to our reliance on the user-centered design process, we were able to revise and retest our icons as needed, so that they eventually conveyed the messages that we intended.

LESSON LEARNED: ADDING INTERACTIVITY

We had particular challenges with the icon we designed to represent time. The initial design as shown in Figure 1 focused on the asking of the question “When?” and distilled this into an image of an analog clock and a question mark. Our intention was that people could use it in many ways. Volunteers and responders might use it to convey a time for an information briefing, for instance. The public could use it to state how long a loved one has been missing.

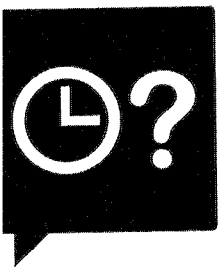


FIGURE 1

Draft of the "When?" icon.

But our participants during testing seemed to find that the open-endedness of the icon made it a challenge to understand. Instead, they tended to suspect it had a very specific meaning, although weren't certain what it was. One Deaf or hard of hearing participant stated that it might mean "my question will be answered at this time." Another responded, "[It] could mean 3:00 or 12:00 [because the similarly-sized hour and minute hands were pointing to 3 and 12]" and "[you] need to be clearer with time." Another participant suggested adding more interactivity, stating: "It would be nice to [be able] to give people a specific time. Like come back to get lunch at 12:00."

In Figure 2, our revised way of conveying time expanded beyond a single icon into a grouping that participants could interact with. In the Show Me book, users could draw hands on a page with a blank clock face using a dry erase marker to indicate a specific time. The time of day icons — morning, afternoon, and night — allow users to indicate a

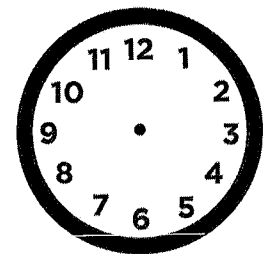


FIGURE 2

Draft layout of the Time page, including a blank analog clock and time of day icons.

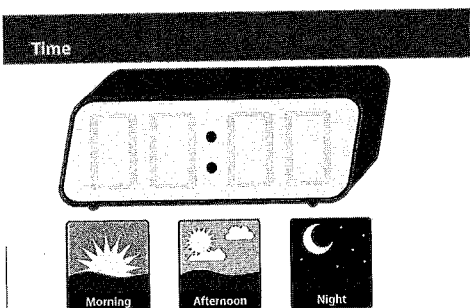


FIGURE 3

Final design of the Time page using a blank digital clock.

less precise time of day. One participant noted, "People always confuse the whole AM/PM thing. It's great that you can just point to the time of day." Overall, users rated this iteration of the time icon more positively, but people with cognitive disabilities struggled with telling time on an analog clock. Some participants suggested that a digital clock might be easier to understand. In the final iteration as seen in Figure 3, we followed their advice and created a digital clock that allowed users to write in numbers using a dry-erase marker in the laminated booklet.

While we originally designed the time icon for the Show Me book, it adapted well to the mobile application as seen in Figure 4. Users can set the time using a spinner and then the time appears on the digital clock icon. The time of day icons appear below the clock automatically based upon the user's input.

Through testing, it became clear that using a single, static icon to convey time would not meet our users' needs. By adding additional icons — sequentially depicting times of day — we created an environmental context for the icon set that made them collectively easier for users to understand. The most vital addition, however, was interactivity. Allowing users to set the time on the clock allowed for a customized conversation based on each person's need.

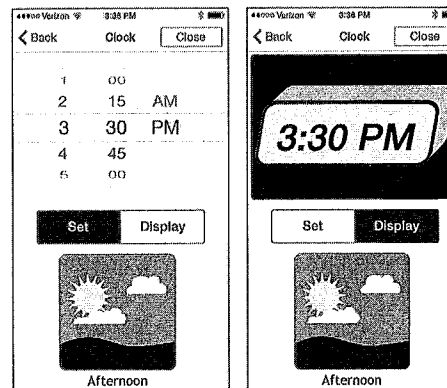


FIGURE 4

Screenshots of the Clock feature in the Show Me for Emergencies app showing how users set time (left) and display time using a digital clock icon (right).

LESSON LEARNED: ANIMATING ICONS

As part of our research process, we conducted a survey of existing AAC communication boards and icon-based tools and found that many focus on identifying feelings, language, body parts, and other ideas, constructs, or objects. However, we found very few that used icons to convey actionable messages.

For our development team, it was essential that we devise a way to convey such messages. For instance, in an emergency, when volunteers go door-to-door before a storm warning people, they have to tell them to evacuate or stay at home. These two scenarios require different, explicit messages, such as "pack" or "move away from windows."

As seen in Figure 5, the initial designs of these icons attempted to communicate actions in singular, static icons. We represented motion through body gesture and directional arrows.

Though users understood some aspects of these icons — like individual symbols within an icon — they missed the overall intended message. For example, one Deaf participant described the "Pack" icon as meaning "I would open my suitcase." Even when the moderator stated that a first responder would be showing the participant this icon during an emergency, the participant still only saw the action of opening a suitcase — not opening a suitcase, packing it, closing it, and leaving. Similar responses to other icons for actionable messages led us to conclude that, at least for

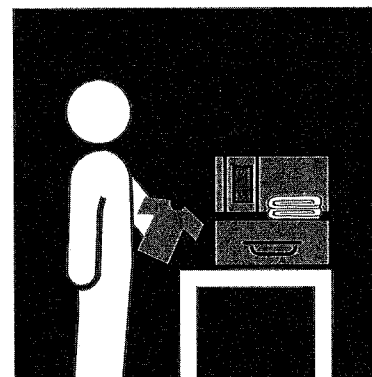
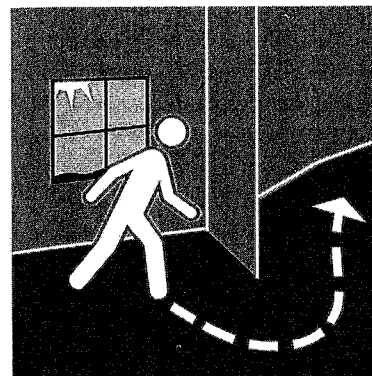


FIGURE 5

Draft of the "Move Away From Windows" (top) and "Pack" (bottom) icons.

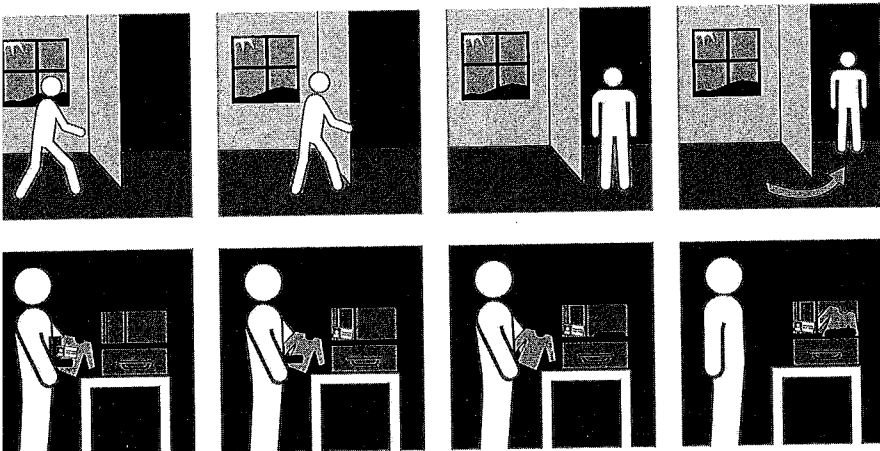
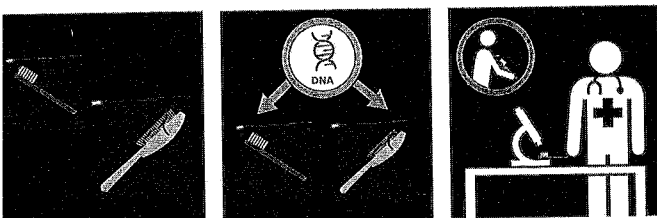


FIGURE 6

frames from the animated icons "Move Away From Windows" (top) and "Pack" (bottom) icons.

FIGURE 7 (BELOW)

series of icons conveying information about DNA, from left to right: toothbrush/Hairbrush, DNA Sample, and DNA Testing.



LESSON LEARNED: GROUPING ICONS

The iterative icon design process wasn't only about fine-tuning the appearance of the icons themselves; it was also about deciding how the icons were grouped and organized, so they are easiest to understand and use contextually.

We confirmed that for some icons, the correct use of grouping was essential to conveying their meaning. For example, the Show Me FAC app — designed for use in family assistance centers after disasters — needed a series of icons about DNA testing. To help identify

some instructive messages, body language and additional instruction were key to conveying the meaning.

While we still used these static icons in the Show Me book, once we started developing the mobile apps we had the opportunity to address this problem in a new way. We decided to animate the icons, so they would run in a loop, a technique that users responded well to. In Figure 6, the frames for the "Move Away From Windows" and "Pack" icons can be read from left to right.

Developing the actionable message icons showed us that movement can enhance meaning — essentially creating a narrative of the steps involved — and convey a more complex idea. However, we knew that too much animation could get overwhelming, so we used it only on the nine icons that we thought required it.

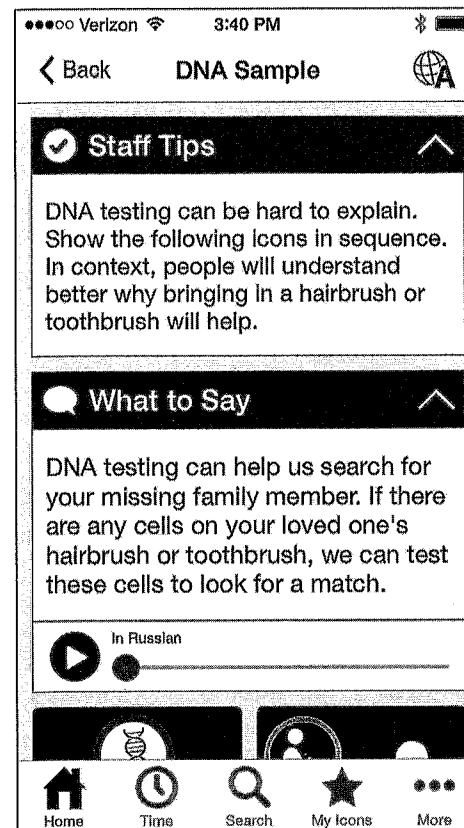


FIGURE 8

Screenshot from Show Me for Emergencies FAC app showing the Staff Tip and What to Say messages that are grouped with the DNA icon series.

missing family members, people waiting at the center often need to bring in a sample of their loved one's DNA, usually from a toothbrush or comb. The message is a deeply upsetting one for grieving family members, and we expected that expressing it with icons would be a challenge. While we always intended to group the DNA icons together, we still tested these images individually to gauge responses. We found that most participants identified certain symbols in the "Toothbrush/Hairbrush," "DNA Sample," and "DNA Testing" icons as shown in Figure 7. But they struggled with the concept of actually *gathering* personal items as a way to help identify a missing person.

Some participants made connections as they noticed symbols, like the toothbrush and hairbrush, that were reused across multiple icons. One participant with limited proficiency in English understood that the toothbrush from the "DNA Sample" icon was the one being tested in the "DNA Testing" icon. Another Deaf or hard of hearing participant stated that "Toothbrush/Hairbrush" icon made the "DNA Sample" clearer and "she'd get a brush with missing person's DNA on it to help identify him."

As we expected, when we presented these DNA icons together as a series, users had a clearer sense of what we were trying to convey. We

reinforced the message further in the FAC mobile app with staff tips (see Figure 8) that coach workers and volunteers on how to use the DNA icon set. By carefully considering the organization of icons, labeling, and messaging, we were able to create new meaning from a sequence of icons that users couldn't understand in isolation.

IMPLICATIONS

For the CommunicateHealth design team, developing the icons for the Show Me tools was an inspiring challenge — from both a design and public health perspective. We were acutely aware of the serious implications of our work. These tools have the potential not only to help a segment of the public with special needs during an emergency, but to save lives — getting people to understand how to protect themselves and their families during life-threatening emergencies. Developing icons that worked — that people could understand quickly, regardless of communication difficulties — could make all the difference during a crisis.

Because this is a case study, it does have obvious limitations. For instance, we were not able to field test the tools, and we do not have data about how the Show Me tools have been used during actual emergencies. While we did test the tools and icons with over 100 people over three years, the budget limitations of a state health department prohibited testing on a wider scale. We do hope to learn more from public health departments that use these tools during a crisis. If possible, we could then refine the tools in the future.

Our paper has clear implications for designers working in the field of public health — and outside of it. As Zender has argued, while the AIGA/DOT icons are still valuable tools, exploration of icon design has remained static for decades (2006). By focusing not only on the design of new, traditional icons but by adding interactivity and animation, and carefully grouping related icons, we have helped push forward what designers can achieve using icons as a form of communication for a broad audience.

The icon systems that designers developed for the 20th century fit their cultural moment — the need for mass reproduction and the aspiration to create a universal visual language. As design moves forward in the 21st century, icon designers will need to consider new contexts, the needs of fragmented and specialized audiences, and the implications of the rapidly growing field of mobile health applications (mHealth). To meet the challenge, designers need to question assumptions about how people understand traditional iconography — and create new systems that will help people understand important messages about their health and safety.

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AWARDS

Federal Emergency Management Agency (FEMA) recognized the Show Me series with the 2014 Individual and Community Preparedness Award for Survivor Empowerment and Integration. Our project officer at MDPH, Samantha Stone, was recognized by the White House's Champions of Change program for Individual and Community Preparedness, in part for her work on the Show Me series of tools.

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