Visual Design of Interactive Software for Older Adults: Preventing Drug Interactions in Older Adults

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Abstract

This article reports findings from formative research conducted with older adults to identify desirable visual interface features for an interactive, educational software program designed for an older population. The features discussed address age-related visual and physical impairments common in older people. Findings include recommendations concerning illustration style and representation of the human figure, type size, face, and configuration of type, color relationships and basic interactive functions.

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Introduction

Preventing Drug Interactions in Older Adults is a study to determine whether an interactive, animated, software program, designed for the needs of older adults, can increase knowledge gains and subsequent health behavioral changes in a representative population of persons aged sixty years and older. An additional goal of the study is to identify and describe features of an interface design that may increase older user's comprehension and enjoyment of the program's content. This article discusses findings from a qualitative prestudy that informed design of the software program now being tested in a clinical trial.

Research Objectives and Problem Scope

Before discussing specific findings from the prestudy, it may be useful to position them in the context of the larger project. The purpose of the study is to develop an effective intervention for reducing harmful interactions among prescription and over-the-counter (OTC) drugs and alcohol in older adults living independently in their communities. The intervention has older adults use the educational software program on laptop computers equipped with infrared sensitive touch screens. Participants do not need to have prior experience with, or knowledge of, computers to use the program. The study is a scientific investigation that compares self-reported knowledge and behavioral outcomes for an intervention group with two control groups who do not use the computer program. It is an assumption of the study that in order for the findings to be valid, the interface must be designed to appeal to, and be broadly appropriate for, the learning styles and psychomotor skills of older adults.

Scope of the problem

People over sixty are particularly vulnerable to injury from interactions among pharmaceuticals and other common substances. Members of this age group are likely to use multiple prescription medications for chronic conditions such as high blood pressure and heart disease, and their drug metabolism rates are more variable than for members of the general population. They are also less able to hear, read and understand oral and written instructions (Bloom, et. al., 1993; Hanlon, et. al., 1992; Pollow et. al., 1994; Salzman 1995; Wallsten, et. al., 1995). Adverse drug reactions account for about seventeen percent of hospital admissions for the elderly, which is a rate almost six times greater than for the general population (USGAO, 1995). Failing to take medications properly is estimated to cost the health care system $25 billion annually, and results in ten percent of nursing home admissions costing $5 billion a year (Task Force for Compliance, 1994). In addition, drug interactions rank between the 4th to 6th leading cause of death in persons sixty-five and older (Lazarou, Pomeranz and Corey, 1998).

Study population

The study population for the project was defined as adults at least sixty years of age by self report who met criteria developed and validated by the MacArthur Research Program in Successful Aging to ensure a base-level of independent physical and cognitive functioning (Wallsten, et.al., 1995). In order to qualify for the study participants needed to be living independently in their communities and had to have visual acuity of at least 20/100 with corrective lenses. Participants also had to have health conditions that required prescription drug regimens addressed in the program (e.g., they must either use anticoagulants regularly to reduce stroke risk or antihypertensives to control high blood pressure).

Phases of the study

Preventing Drug Interactions in Older Adults is a study in two phases. During Phase 1, the Pilot Year, the educational software program was developed using formative research with small groups of older adults who met the defined criteria. Findings from this research make up the body of this paper. The program was then tested in a pilot study with sixty subjects representative of the study population (1). Results from the pilot test are reported in Neafsey, Strickler, Shellman and Padula (2001). Phase 2, is a full clinical trial of the completed program with three-hundred subjects in three Connecticut communities. Method for the study and preliminary results from the extended clinical trial are reported in Neafsey, Strickler, Shellman and Cartier (In press). The three-year clinical trial is still underway at this writing.

Formative research method

The main objective for the formative pre-study was to identify specific visual, stylistic, verbal, temporal and navigational features of alternative software prototypes, that either promoted, (or detracted from), user appeal and comprehension of program content.

Two focus groups of six volunteers each (three men and nine women) met once a week over nine weeks to evaluate alternative components of progressively more completed prototypes. Focus group participants were recruited from the Center for Learning in Retirement (CLIR), an ongoing program of lectures, seminars and workshops at the University of Connecticut that is attended by over 300 older adults from the surrounding community. Ages of the participants ranged from 62 to 87, with a mean age of 77. Participants met all of the study criteria for subjects in the larger study as described above and in Neafsey et al. (2001). (Each of the focus group members was given a $5.00 cash incentive award for each meeting attended.)

The nine focus group sessions, which met for one hour each, alternated weekly between sessions devoted to visual features of software prototypes, and sessions devoted to the language level of the text. The sessions devoted to language were used to identify vocabulary that participants found difficult to understand. Older adults have been found to comprehend health information at a full four years below their reading grade level of non-technical prose (Williams et al, 1995). We followed recommendations that the health information be provided at no more than a 6th grade reading level (Laubach and Koschnick, 1977; Plimpton and Root, 1994; Williams et al., 1995), and explored particular vocabulary and descriptions of pharmacological processes with participants to arrive at a final text for the printed materials and interactive program. During these sessions participants also evaluated learner prompts and questions embedded in the interactive quizzes that followed each section to reinforce learning. Method for the language sessions is reported in Neafsey et al. (2001).

■ Qualitative study method

The visual sessions employed focus group methodology within an early product-testing environment. The purpose of the sessions was not to observe, or to "test" participant's use of completed prototypes, but rather to elicit social dialogue from the group about particular visual and stylistic features of alternative prototypes prior to designing the program. Little has been written to date about older adults' aesthetic preferences for visual presentation of information. This study is a preliminary effort to address this gap in the literature.

Group interviewing uses the principle that people who don't know each other, but who recognize that they have things in common with others present, will often enjoy sharing their thoughts and experiences about a topic (Krueger, 1993). Although a focus group setting is an inherently artificial environment, a discussion among peers about shared problems can evolve toward themes that are relevant to the participants without overt direction by a researcher (Morgan, 1988). Since the study area was new to us, we wanted the older adults to define their needs and wants from their own perspectives.

The focus groups met in a CLIR seminar room to evaluate elements of software prototypes. The focus group methods of Anderson and colleagues (1996) and Krueger (1993) were adapted to a computer product environment. For the visual sessions participants sat in a semi-circle around a 17-inch Macintosh full-screen display as prototypes were brought up on the screen for discussion. Since the participant's distance from the screen was greater in the sessions than would be the case in actual use, the screen presentation during these presentations was larger to compensate. (The final image size for the program was 12 inches on 14-inch IBM Thinkpad laptop computers, with 1 inch of perimeter space lost to the touch screen attachment.) Final alterations were made to the software program based on observations of 30 subjects who used two completed, fully interactive sections of it during the pilot test and prior to its use in the clinical trial.

■ Creation of Prototypes

Before designing prototypes for the discussion sessions, the research and design teams reviewed the literature on age-related losses of visual and physical function in older adults associated with reading and computer use. Information was available regarding age-related losses in ability to read printed texts (Morrell and Echt, 1997; Vanderplas and Vanderplas, 1980). However, somewhat less is available regarding older adults' ability to read, and to learn from, computer screens (Morris, 1994). Specific literature on older adults' stylistic and aesthetic preferences for learning software was not found (3).

Given the information available, the design team assumed that a loss of visual acuity would be present among participants. However, we also made a conscious effort to suspend our prior judgments about the capabilities and preferences of older adults with respect to computer use. This user population was new to us, and little work has been documented in this area, especially regarding seniors' aesthetic preferences. We also assumed that any prototypes we created would reflect the aesthetic orientations of our own design educations and experiences, and considered that these might differ from preferences expressed by the study population (4).

In order to address these potential sources of bias in our process, we developed three initial alternative prototypes with different stylistic features. Our objective was to encourage a "compare-and-contrast" discussion environment in the sessions that would require participants to move beyond simple affirmations of work shown (5). By presenting two or more options for particular visual features, we created a situation in which participants would need to articulate specific reasons for preferring one style or device over another. This approach differs from product testing environments where only one completed mock-up of a design is presented to participants for use and comment. We also chose to introduce the program in gradually more comprehensive states, beginning initially with only still images from the animations. This allowed us to isolate elements participants disliked or found problematic prior to testing completed, and therefore more difficult to criticize, prototypes.

In the first session three still screens from the alternative designs were presented for discussion *(figures a-c)*. Questions for this session concerned general aesthetics and legibility of the images. Matters such as liking or disliking of the illustration style, the gender and race of the human figure, completeness of the organ set and preferences for color scheme, as well as practical matters such as size and type face of text blocks were discussed. The images were introduced one at a time, each being discussed to a natural conclusion before another was introduced. The moderator opened discussion of each new prototype with a general request for comments on the appearance of the image before asking planned questions. The purpose of this approach was to record first responses and issues raised from participant's points of view before directing the group's attention to specific features. Once all three prototypes had been presented, the conversation flowed naturally toward a compare-and

-contrast discussion as participants referred back to prior images. Conversations were driven by participant-led themes as much as possible, with the moderator prompting for pre-set questions only when spontaneous dialogue flagged.

In the second visual session a fourth prototype design was presented that had been created based on comments from the first session. The first three designs were animated for this session, as was the new design (again, with clear differences in animation features among the prototypes). In this session matters such as arrangement of headings, images, and text blocks on the screen, as well as the rate and manner in which kinetic texts appeared on the screen were discussed. Stylistic factors were reviewed and a direction for the final look of the program was established.

In the last three visual sessions alternate versions of animations of different pharmacological processes (and/or interactions) were shown to determine whether participants could easily comprehend the ideas being illustrated. All animations in the later sessions featured the visual prototype style preferred in the first sessions. Preferences for cueing, speed, emphasis and animation devices such as circling body parts under discussion before zooming to enlargements of internal organs were discussed.

Our decision to alternate the meetings between language sessions and visual sessions had two beneficial effects. First, it permitted two weeks time between visual sessions for the design team to develop new prototypes. Second, it provided momentum for the participants who had committed to attend weekly meetings, but it broke the monotony of either type of session. The participants found the verbal sessions to be more tiring and made statements to the effect that they looked forward to the sessions where they could "see movies." Participant interest in the computer program was high and we observed no change in the quality of participation from the first to the last session.

■ Focus group discussion environment

Moderator neutrality

Prototypes were presented to participants in as neutral and equivalent a manner as possible. Although the moderator was a member of the design team, references were made only to "the people who are designing this" in order to disassociate the images from the moderator (Sless, 1996). Although participants were assured that no one's feelings could be hurt, some did express concern about hurting feelings early in the sessions. Participants were encouraged to regard all thoughts, whether positive or negative, as important for the study. We assumed that there would be a tendency among participants to say polite things, and/or to say what might be perceived to be the "right" thing (Morgan, 1988). However, in addition to this effect, which was present, a great many useful criticisms were made, and participants were able to express clear dislike for particular features.

Prompting

Comments made in focus group environments have to be evaluated with regard to the context in which statements are made (Albrecht, Johnson, and Walther, 1993). Whether a comment is offered spontaneously, or has to be prompted by the moderator, is important for understanding its meaning. Comments made without prompting tend to indicate that a matter is salient, (is important to the participant and comes readily to mind), but also that it is not particularly sensitive. An issue that must be prompted can either be interpreted as being less important to the participants, (it doesn't occur to them to comment on it), or, it may be a topic that they are uncomfortable discussing in a group setting.

Focus group analysis

All statements made in a focus group environment need to be interpreted within the framework of the entire conversation. Interpreting motivations behind comments is subjective and can be a source of error, although context can provide guidance for assessing the significance of utterances. While some responses are obviously richer in detail than others, any single comment can only be assumed to represent the view of one individual. Furthermore, any response must be assumed to represent, at least in part, what an individual wants others in the group to think he or she believes, not necessarily what he or she actually believes (Morgan, 1988). One or two talkative individuals can also dominate a focus group and this was the case for both groups in the study. The principle speaker in each group was identified in the transcripts as Participant #1.

Findings

Despite the limitations of what can be firmly asserted from focus group research, the sessions provided insight into a number of matters related to participant's responses to the computer program. Participants spoke openly and matter-of-factly about age-related issues such as diminished eyesight. They communicated their likes and dislikes for aspects of graphic style clearly, once prompted. They also talked about their existing beliefs regarding interactions between prescription and over-the-counter medications and alcohol. These comments were useful for identifying present misconceptions.

What follows is a discussion of the design features of the PEP (Personal Education Program) that evolved in response to the participants' comments and preferences.

Emotional tone of the design

A consideration that guided creation of the prototypes was that the behaviors addressed in the program are normative. While older adults' use of OTC medications and alcohol can lead to serious medical complications, these practices are not aberrant in any way. Active seniors are people who, in most cases, have been drinking socially and responsibly for decades and who take aspirin and other OTC medications for headaches, colds and upset stomach as do other members of the population.

What has changed for older adults as a group is that age-related factors make some individuals less able to metabolize pharmaceuticals effectively, and their greater use of prescription drugs for managing chronic conditions makes harmful interactions more likely. The fact that the behaviors that put older adults at risk are normative suggested a straightforward approach to the content. Comments from participants supported our decision that elements of persuasion would be largely unnecessary, and perhaps off-putting, in the program.

■ Type size

Type size was a subject that was mentioned by nearly all participants without prompting. Individuals were very quick to say that type was too small, or that they had trouble reading it. Participants regarded most of the initial text settings presented to be too small. This is consistent with research on eyesight and aging that suggests that older adults need larger type sizes than younger readers to read text comfortably (Morrell and Echt, 1997; Vanderplas and Vanderplas, 1980). The design team was familiar with this literature, but it is significant that a bias toward use of smaller type and generous compositional "white space" prevalent in design culture and education (6) manifested itself in our initial prototypes despite this preparation. Participants in both focus groups expressed annoyance that available space was not used for making type larger.

A.3 Maybe you could enlarge that [text] slightly
A.4 large type. yeah, larger type helps
A.2 you got a lotta room there
B.2 it's hard to read
B.4 the print could be a little bit larger
B.5 there is plenty of room there

(Participants are identified in excerpts as members of either group A or B, and by the number assigned to them during transcript analysis. In the first two visual sessions, from which most of the comments reported here were drawn, only five participants were present in each group.).

■ Type style and character

Unlike type size, comments about type style had to be prompted. A simple explanation for this is that people who are not trained in typographic detailing do not view type variables with as much interest as communication designers. However, style is also a matter of taste, and some members may have felt uncomfortable talking about aesthetics in a group setting, especially if they felt they knew little about type or graphic style.

While comments about type characteristics were not offered spontaneously in most cases, type style did have salience for the participants. Once opinions were voiced they were strong. Participants generally lacked a vocabulary to discuss type features, but their comments are revealing.

A.1 Oh I like it. It's easy to see. I don't like the curlicue kind [serif faces] I like the, uh...[participant doesn't have a word to describe sans serif]

A.2 Block letters.

A.1 Block letters! Yes, I like that much better. It's easy to read. That's what we're accustomed to reading—we read the newspaper and you don't have too much curlicues. You have it much more block letters.

The design team's prediction that older individuals would be more comfortable with serif type faces than with sans-serif faces was not supported. Since all texts in the PEP were written to be brief and to read like display type, the participants expressed unanimous (7) preference for the use of all Stone Sans Bold type in the third prototype. This is not surprising as Stone Sans was designed, in part, for readable screen display.

The final design employed 20 pt. Stone Sans Bold for text type, and 28 pt. and 32 pt. Stone Sans Bold for headings as created for a 640 x 480 pixel screen display. Some tertiary labels, such as generic names of pharmaceuticals, were presented in 18 pt., but the preferred minimum type size for the program was 20 pts.

All type had to be set bold to be read comfortably by the participants. This eliminated weight change as a variable, so type size and position in space became the principal means for text differentiation. Body text was set flush left/ragged right, and was set in small blocks of text for rapid reading. Line lengths were typically two to four words in length. The longest block of continuous text was five lines. Texts were written for this presentation format and were tested to maximize clarity and brevity.

Participants were also sensitive to capitalization. They were disturbed by headings that were all lower case or employed only one capital letter at the beginning of a line with subsequent words being all lower case. Here, the modernist preference for a limited use of capitals (8) was in conflict with their expectation that headings should employ initial capitals throughout. Comments on capitalization were unprompted.

A.5 I think the capitals help out [initial capitals in heads], where you don't have them there [in figure #1]

B.1 and the capital A on the antihypertensives seems to make more emphasis on it. the little a...

Participants also expressed strong interest in seeing particular words in the text emphasized. However, because text was already set bold, increasing weights for emphasis was unpleasant. Participants had difficulty perceiving words set oblique, and they could not distinguish hue variations in the text well, a finding consistent with a research demonstrating loss of color perception with age (Kline and Schieber, 1985; Morris, 1994). However, participants indicated that they wanted to see keywords underlined for emphasis. This contradicts fine typographic traditions, but it reflects participants' comfort with typewriter conventions as was expressed in the comment—"We're used to seeing it [type] underlined." The decision to underline words for emphasis is partially supported by empirical research (Taub, 1984).

The issue that elicited the greatest number of spontaneous comment was contrast. All initial prototypes were found to lack sufficient contrast. This is consistent with studies suggesting that the ability to perceive light/dark and color contrasts diminishes with age (Kline and Scialfa, 1997; Charness and Bosman, 1992).

The illustration style of figure 1 caused basic contrast problems for participants. Figure 1 defines the contours of the human figure with a gradation of neutral color to imply volume. Difficulty discriminating low contrast edges of shapes is a visual deficit associated with aging (Morrell and Echt, 1997) and several participants found the smooth transitions from gray to white to be indistinct.

The needs of older viewers for strong contrasts in imagery contradict a traditional orientation in color theory education for designers toward reducing contrasts of hue to achieve harmonious color composition (9). Like the use of small type sizes, this bias toward working with hues similar in value and/or "graying back" color contrasts can amount to illegibility for older audiences.

The imagery with which we were working—an anatomical figure displaying internal organs—required some means of differentiating contiguous shapes. Contrasts of hue alone *(as presented in figure 2)* were not sufficient for a number of the participants. One of the more descriptive speeches regarding this feature indicated the seriousness of the contrast issue for older viewers.

A.1 Yes, it seems too light to me, the pill. I mean, you might think that was just a distortion on the picture, rather than—if it didn't have 'blood pressure pill' written under it, I'd think it was something else.

When a comment that an image is "too light" is expressed in a vague way it is possible to regard the matter as one of taste or degree. However, when a viewer describes an important component of an image as looking like "a distortion on the picture" it's clear that quite a bit more is at stake.

Figure 3 was regarded unanimously as the easiest figure to see, but it was also found to lack sufficient contrast. It employs a dark outline of a consistent weight around the figure and all organs. Participants regarded the outline as too thin in the first prototype, and also insufficiently dark against the colored background, but comments were consistently supportive of the illustrative approach.

A.3 I like this one the best. It's easier to see, but the size of the type... It hits you, and that's what you're interested in.
A.5 the pill stands out there
A.1 I like the looks of the graphics...

■ Color perception

Loss of color perception appeared to exacerbate difficulty with edge discrimination as well. Participant #5 in group B had difficulty distinguishing between hues close in value and on several occasions referred to elements, particularly colored type, as being difficult to see because "it's shaded," or "it blends."

In figure 3 text was rendered not as black, but in two hues—a dark teal, and a dark red brown. Comments from the first visual session with group B reveal that subtle color differentiations of this sort may not be perceived by older users.

B.4 well, I think the red emphasizes that it's antihypertension
B.5 I thought that was black, is that red?
B.4 no, brown red
B.3 the box is red
B.2 this is red too, the antihypertension, is red
B.5 I didn't even notice it
B.3 I do think black print would be easier to read

In subsequent prototypes the type was rendered in darker values but retained a slight differentiation in hue. Pure black type was avoided because it introduced a visual harshness to the screens, but the final color values were nearly black (10). For participants who could see color distinctions in the type this differentiation provided an additional level of hierarchy. For those with less ability to distinguish hues, all type appeared black.

■ Glare

Despite participant's expressed need for sufficient contrast on the screen, particularly for texts, we found that achieving good contrast is not as simple as using black type on white ground. As soon as participants in both groups saw figure 3 presented on a warm blue background they expressed a preference for the colored background because it reduced glare on the screen.

A.1 and you know that if you're going to be in facilities with lights like these, fluorescents, it [this screen design] doesn't show as much glare as either of the others. It tends to be much better...it seems to kinda settle things down as far as the light reflections

This finding is consistent with literature on older adult's higher sensitivity to glare (Kline and Scialfa, 1997; Kline and Schieber, 1985). Because the iris and pupil undergo change with age, older adults experience reduced ability to adjust to intense light sources.

The issue of glare did not come up during discussions of the first figures. However, once the blue field was introduced, it was unanimously preferred over the white backgrounds in unprompted comments. This suggests that designing effective screen images for older viewers may involve finding a balance between the need for strong contrasts in the imagery and reducing glare on the screen overall.

A light warm blue was selected for the final background color for several reasons. Older adults have the greatest difficulty distinguishing hues of similar value in the shorter (blue and green) wavelengths (Kline and Scialfa, 1997; Morris, 1994). By using blue as the background hue, other visual elements such as flesh, organs and cues could be differentiated in the red, pink, orange and brown range. The blue background also made the flesh colors of the anatomical figure appear warmer and healthier. Some research has also suggested that blue is the color most often identified by older adults as their "favorite color" (Silver and Ferrante, 1995). It's use as the dominant hue on the screen may, therefore, enhance the appeal of the program for some viewers.

■ Background

Participants preferred a plain background of a single hue and light in value over more graphically complex approaches. They regarded all shaded bars, layers or other devices that divided areas of the screen, called out heads, or separated text from image to be distracting, and as interfering with comprehension of the information.

■ Illustration style of anatomical figures

Figure 1

As discussed in the section on contrast, figure 1 employed a technique for defining the contours of the figure and organs with a smooth gradation. This was intended to give the figure volume, and presumably, a more natural appearance. In this respect it could also be said to be the most visually sophisticated rendering style presented. Figure 1 also used a more traditional medical illustration style. The pose was taken from an anatomy text book with a frontal body and head in profile. In order to avoid racial implications, the figure was not given a skin color. Rather, the edge gradation was a warm gray and emphasis was on the interior of the body, instead of on surface flesh.

Figure 1 was also designed to represent an older person. It had a larger, mature nose, and the body shape was of an older, formerly fit man with some muscle loss. The figure had no hair.

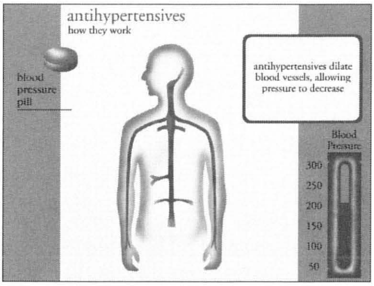

Figure 1: Prototype 1

Participants did not like this figure. As mentioned above, the gradation was hard for some in the group to see. Participants expressed that the figure looked "old" and they did not find this appealing. They also expressed discomfort with the partial profile stance, a position that seemed unnatural to them. The absence of facial features was also perceived to be impersonal. Participants only mentioned the unnaturalness of the position, the lack of facial features, the oldness, maleness and baldness, of the figure when prompted, but it is also possible that rather than looking lifelike or sophisticated in its rendering, the gradation and neutral colors caused participants to perceive the figure as machine-like, or worse, cadaver-like. Dislike of this figure was unanimous.

■ Figure 2

Figure 2 was rendered in a more diagrammatic style. The objective for figure 2 was to present the figure with simplified and more geometric shapes at the expense of naturalness. The figure and organs were presented as flat planes of color against a white ground. Of the three figures, figure 2 had the least contrast.

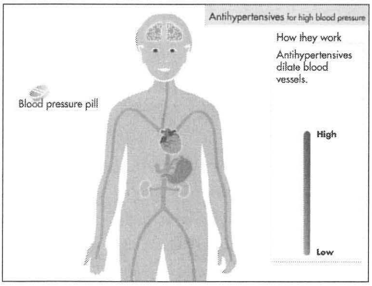

Figure 2: Prototype 2

In spite of the overall lightness and low contrast of the image, (points which were raised repeatedly in unprompted comments), the style of figure 2 was much preferred by participants over figure 1. Figure 2 was unanimously perceived to be female, and the presence of facial features and hair were mentioned as principal reasons for its greater appeal. The figure was entirely frontal, which was preferred to the partial profile of the first image. The body shape was also rounder, implying the presence of some body fat, and its simplified facial features had a youthful appearance, although the presumed age of the figure was not mentioned. The image was colorful (mainly pinks, oranges and light blues). In order to distinguish the organs from one another, some were assigned unnatural hues; for instance, the stomach was rendered as a sky blue. Participants did not express discomfort with abstraction in the color scheme. They appeared to accept it as symbolic.

A.5 it's showing the heart, which I think is important
A.1 and the kidneys, and the pancreas, and whatever that is—
the stomach or the pancreas—stomach is blue

■ Figure 3

While figure 2 was generally preferred over figure 1, both groups expressed a unanimous preference for the graphic style of figure 3. Like figure 2, it was colorful and flat, with principal differences being its colored background (light, warm blue/gray) and dark outlines around the body contour and organs. Although diagrammatic, figure 3, was also rendered more descriptively than figure 2 in terms of definition of facial features and organs.

A.1 but this is a nice figure. it looks more like a human,
too, you know.

Figure 3 was criticized for being too light in value, and for lacking contrasts. However, once the contours were thickened and darkened (*figure 4*), participants in both groups expressed satisfaction with the style solution and did not want to see the other figures again, even with new variations.

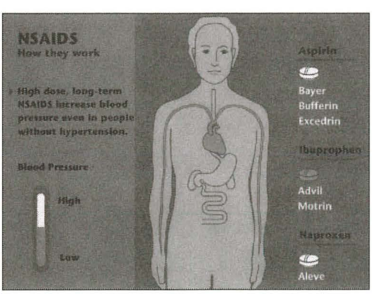

Figure 3: Prototype 3

■ Representation of the figure

One of the goals for design was to create an anatomical figure that was gender and race neutral. We were only partly successful in achieving this end as will be discussed below.

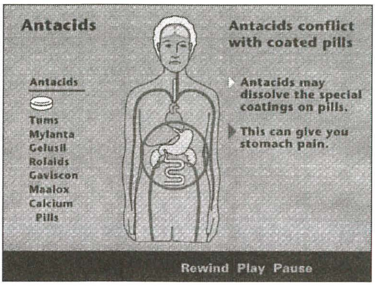

Figure 4: Prototype 4

Comments about racial and gender characteristics of the figures had to be prompted by the moderator in all cases. Several explanations for this are possible. First, participants may not have thought about representation until they were asked to comment on it, or identity matters may not have seemed important to them given the informational purpose of the program. However, race and gender are relatively sensitive issues in American culture, and participants may also have been reluctant to discuss their perceptions in a group setting. Most of the joking in the sessions occurred during these conversations. Prompted discussions of identity tended to be cut off rather quickly by someone raising another, usually more technical, issue.

Agreement was unanimous in both groups that figure 1 appeared to be male in its body shape and features. Figure 2 was perceived unanimously to be female in its body shape and features by both groups. Figure 3 was discussed in group A as appearing somewhat gender neutral.

A.1 it looks like a person. it's a human body. an 'it'.
A.5 essentially, a generic person

Group B, a group of all women, expressed concern that figure 3 appeared to be a white male, although it did have some features they regarded as ambiguous.

B.1 it looks like a male to me
B.2 it looks like a male
B.1 but if the hair was removed it would look sort of non-gender
B.2 um-hmm
B.5 you want it without hair?
B.1 but you know, people get all bent out of shape if they identify a male, instead of a female—the shape of the head [on this one] they wouldn't know which it was

Both groups also made comments that were dismissive of the significance of gender and identity features altogether.

A.2 it doesn't matter what it looks like
B.3 what are we supposed to be looking for?
B.2 that's what I'm saying, what is there in the figure there?
B.1 I don't think it would make any difference would it, male or female?
B.5 I can't tell a male from a female any more anyway

It is impossible to know for certain whether these comments reflect genuine beliefs (that the features of a figure do not influence a viewer's perception) or whether the comments imply unease with the questions. What can be determined from the transcripts is that despite these comments, some diversity consciousness was present in the participants, and, at least publicly, this group of older, white adults wanted the program to express some values of inclusiveness.

For subsequent sessions, figure 3 was reworked to blend male and female features to a greater extent (*figure 4*). Race proved to be a more difficult area for achieving perceptions of ambiguity. We found that very slight differences in line direction, length and shape produce racial associations in even simplified images. After the focus group sessions were concluded and final production was begun, we made the decision to create a series of six figures that reflected different racial characteristics. Some of the figures appeared to be more male, others more female. In the context of the completed program, mixing up the appearance of the figures helped to break the monotony of the similarly formatted frames. Thus, for each of the four health categories, (high blood pressure, blood thinners, upset stomach and pain relief) five to eight different animations were presented with different racial features dispersed among the figures. This reinforced the message that all groups suffer from common drug interactions.

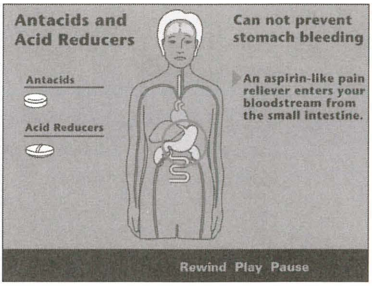

Figure 5: Screen sample from the final interface design showing one of six ethnic figures.

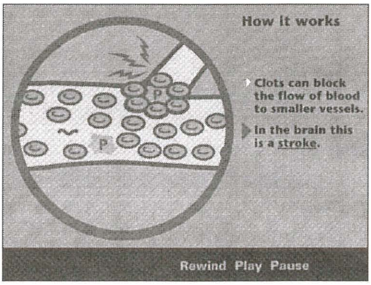

Figure 7: Screen sample from final inteface showing zoomed anatomical detail.

■ Completeness of organs in the anatomical figure

Another matter tested was the anatomical completeness of the human figure—specifically whether participants preferred seeing only the system under discussion in a particular animation, or whether they wanted to see a more complete set of organs at all times. We expected participants to prefer a simplified presentation, but we found just the opposite.

The first topic discussed was blood pressure, so we presented figure 1 showing only the circulatory system. Figure 2 displayed some additional organs, including the brain, stomach and kidneys. Figure 3 showed kidneys, stomach and a simplified digestive tract. The matter did not have to be prompted. Soon after figure 2 was displayed, both groups mentioned that they preferred seeing the more complete organ set. Their desire to understand drug side effects was fairly keen and they wanted to be able to "see" in the animation if a drug affected any vital organs, particularly the brain. Comments about the brain arose spontaneously throughout the discussions.

A.1 and, I like the one [#2] that shows it goes up to the head—I like that part, because it does go up to the head—to show that it does go all to the whole body
A.2 ...this one—you can see more veins in his head
A.4 ...I like to have more
A.2 you want to have guts in there?
A.4 yes
A.1 yeah, I want guts too, guts and veins, and goin' up into the head, and the works!

B.2 but it does show where most of the organs are located
B.1 now will any of the things [pharmaceuticals] identify the brain itself, any effect on the brain?
m some of the animations will. what do you think about seeing the brain?
B.1 well, I'd like to see it there, if some of the things are going to affect it. The other one didn't really have any [figure #1 did not have a brain]

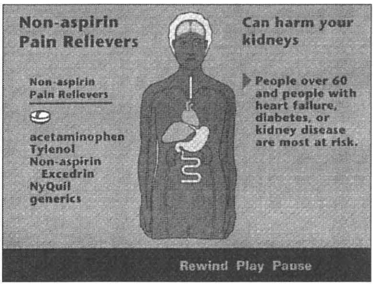

Figure 6: Screen sample from final inteface design showing another ethnic figure.

Although the participants did not mention reasons for wanting to see the brain, their concerns are easy to understand. Many medications can cause temporary mental dulling, drowsiness or disorientation. Active older adults particularly fear these conditions as they can lead to incidents that result in loss of independence. Stroke is also a primary health concern of older adults as one stroke can quickly lead to permanent losses of mental functioning and independence.

■ Information hierarchy

Standard conventions for information hierarchy and placement of elements on the page were preferred over the non-standard variations tested. Participants wanted to begin reading from left to right, and once they were at the right they wanted to be able to stay there.

A.5 where they have it [body text on right] here now. you can just drop down and read it

Participants did not want to have to scan the field for new information and did not like to see typographic elements too dispersed on the page.

B.5 the type is...
B.4 it's like you've got it all over

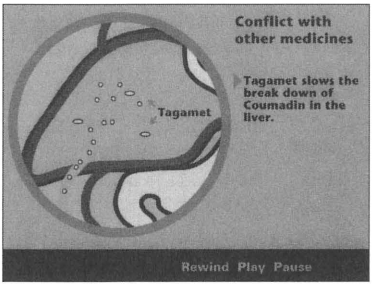

Figure 8: Screen sample from final inteface showing zoomed anatomical detail.

■ Interaction design

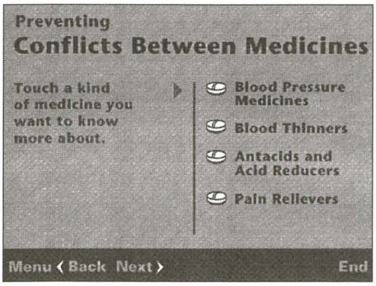

Figure 9: Screen sample from final inteface showing a sample menu page.

Standard conventions for interaction design were also preferred. Some basic functions were tested by intentionally using non-standard relationships (e.g., on some prototypes forward and back positions were reversed in the menu bar from their relationships on standard electronic equipment). It was clear that the older adults in the groups were familiar with the operation of home VCR equipment; they noticed discrepancies and they expected the interactive program to follow VCR conventions.

Several of the participants had home computers and a few used the Internet regularly. Those with Internet experience expected the program to work like the Internet. Others had little experience with computers and/or interactive environments, but VCR controls were assumed by the participants to be natural standards upon which the interface should be based.

Participants strongly preferred prototypes that contained graphical cues over those that did not. They wanted to see a bright red arrow appear on the screen to attract their attention every time a new text block appeared. They tended not to notice that text content had changed if they were not cued. Parts of the body that were under discussion in the text were circled dynamically in bright red. Some of these circles then zoomed out to fill the screen so that a "microscopic" pharmacological interaction could be animated.

Interactive functions were kept to a minimum to reduce navigation confusion. During the pilot test it became clear that some users with less mental and perceptual functioning needed to be able to proceed through the program in a strictly linear way. For these users the interactive script was written so that they could advance through the entire program by simply touching the "Next" button at the bottom of the screen after each segment ended. Other users with higher levels of functioning and more experience with computers wanted a second level of interactivity so that they could make selections by touching active areas of the screen, just as they might use the Internet. The final program design being used in the clinical trial employs both levels of interactivity.

■ Bifocal corrective lenses

Early in the sessions it became clear that the use of bifocal eyeglasses created problems for some users, and that use of bifocals by users would have to be assumed to be a condition for use. In the focus group environment the display field was a 17-inch, vertical computer monitor. Participants wearing bifocals had to adjust their head positions frequently and uncomfortably in order to read the screen through the

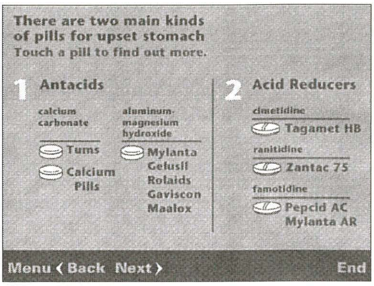

Figure 10: Screen sample from final interface showing a sample menu page.

magnifying lens in the lower half of their glasses. In the pilot test the program was used on laptop computers equipped with touch screens. Here the problem was found to have been largely eliminated because of the more natural reading position of the laptop configuration.

Standard interaction design protocol tends to recommend positioning menus at the top of a screen. In our laptop touch-screen environment we placed the menu at the bottom of the screen so that users wearing bifocals would be able to focus on these selections more easily and with less head adjustment. This location is also consistent with conventions that position "next" or "for more information" buttons at the bottom center or bottom right corners of a screen (Kristof and Satran, 1995). For some users the "next" button was essentially the only interactive function used.

■ Sound

A decision was made early on not to use sound in the program. Nielsen and Shaefer (1993) have reported that older users, unlike younger users, find computer programs more difficult to use and follow when they incorporate sounds.

■ Motion

Design of motion for older adults must be slower and more consecutive than moving graphics for younger audiences. Whereas younger people may enjoy the aesthetic experience of seeing multiple events occur simultaneously on a screen, our participants found simultaneous events frustrating. This is fully consistent with studies of older adults and motion phenomena. Perception research demonstrates that visual tracking skills generally diminish with age (Kline and Scialfa, 1997; Morris, 1994).

From our sessions we determined that only one important event involving motion could happen at a time. A detail area could zoom large while other elements faded (and this particular example of simultaneity was preferred over two-step zooms), but events involving program content needed to be sequential. The base transition time for events was at least three seconds in duration for the viewer, with five seconds being standard. Two to three lines of text (six to eight words) required a minimum of five seconds of display for comprehension, and texts of up to six lines required ten. Important texts were generally displayed for at least ten seconds.

The actual playing time of a computer animation will vary depending on the speed of the computer on which it is played and other factors such as available memory. Given this changeable environment we tested the animations with focus group participants by looking for a base number of seconds to be allowed for different kinds of transitions. Animations produced on different machines could then be slowed down or speeded up within the Macromedia AuthorWare program to play at appropriate speeds on the laptop computers.

Not surprisingly, younger individuals have tended to perceive that the animations move too slowly. Nursing students being trained to deliver the program to older adults in the home trial were frustrated by the pace and often suggested that, "A could happen while B is transitioning...," or the like. However, older learners clearly need a greatly reduced motion environment for comprehension.

■ Generalizability

The findings reported above are specific to the program developed for this project. However, one of the striking things about the project was that nearly all of the relevant resources we found noted the small amount of empirical research available in the area of older adult's preferences and requirements for computer interface design. Because focus group studies are not generalizable to a larger public (due to their small sample sizes), the findings reported here can only be assumed to represent the contributions of twelve individuals. Nevertheless, we hope that this report may provide a needed starting point for others intending to design interactive materials for older adults in the near future. Further, we hope that this report may stimulate further refinement of methods for studying the design implications of aesthetic preferences and practical thresholds required by older adults and other user-groups for visual, on-line learning materials.

■ Conclusion

People over age 60 are particularly vulnerable to injury from interactions among prescription and over-the-counter medications and alcohol. The study Preventing Drug Interactions in Older Adults is an effort to create an effective interactive software intervention to reduce the risk of certain harmful interactions in a representative population of independently living seniors.

Findings drawn from the qualitative pre-study, conducted to guide design of the software prototype, suggest that particular visual features of interface design may enhance comprehension, appeal and ease of use in such a program for older adults. Specifically, interrelated visual factors such as use of bold, sans serif type in sizes of 18 points or larger, strong contrasts for text and images, use of bold, descriptive outlines in illustrations, and a simplified and glare-reducing background, may enhance the appeal of the program for older users. These factors may mean the difference between legibility and illegibility for some. Animated components of such a program need to play at slower speeds than might be preferred by younger people. Strong visual cueing and clear, simple navigation functions are especially important for this population. In addition, we learned that older adults were able to express clear preferences for particular approaches to illustration style, typography and representation of the human figure when presented with alternative prototypes. Some of the preferences expressed by participants in this study contradict standards of aesthetics and stylistic orientations commonly taught in design education programs in the US.

■ End Notes

1 During the pilot test, nursing students observed thirty subjects in a one-on-one context as they used completed, interactive segments of the program. The students noted any difficulties encountered by the participants during this usage. Alterations were made to the program based on this observation period prior to its use in the clinical trial.

2 The objective of the clinical trial is to measure knowledge, self-efficacy,** and self-reported self-medication behaviors in an experimental group of older adults after they use the software program as compared against a group that does not use the program, but receives only a conventional printed text containing the same information. (The conventional document is a word-processed, text-only fact booklet, containing the same text as the program. It is similar in form to "best-practice" printouts provided by some pharmacists. The text is set in 14 point Arial typeface [IBM Helvetica] and is written at a 6th grade reading level.) Results from a control group that receives no intervention at all, but that completes the same battery of questionnaires at identical time intervals, will be compared against those of the experimental and conventional intervention groups.

** Self-efficacy, or a person's level of confidence that he or she can successfully complete a task or achieve a goal, is theorized to influence user outcomes in this study. Self-efficacy is a construct central to Albert Bandura's Social Cognitive Theory (Bandura, 1977, 1986, 1997) that considers the influence of self-reflective processes on behaviors. Self-efficacy is not a fixed personality trait like self-esteem, but is related to whether an individual attempts, persists and achieves successful completion of a particular task. Self-efficacy has been shown to offer explanation of performance of behaviors beyond knowledge alone (Strecher, DeVellis, Becker and Rosenstock, 1986). Investigators have found small to modest correlations between self-efficacy and actual measures of knowledge for health related tasks, suggesting that each cognitive construct measures a separate component (Murdock and Neafsey, 1995). Such findings and others have been interpreted repeatedly to mean that both knowledge and self-efficacy are important and different cognitive precursors of behavior (Bandura, 1977, 1986, 1997; Froman, 1996; and Strecher, et al., 1986). According to self-efficacy theory, subjects who believe that they will be able to comprehend, and act on, information will be more likely to do so effectively than individuals who lack such confidence. In this context, a principal objective for design of this program was to make the learning task pleasant and manageable for older adults, thereby reducing user's self-doubts about their ability to learn and apply the concepts.

3 In *Dynamics in Document Design*, (1997) Karen A. Schriver noted that "little work has assessed the design of hardcopy or online information for this population [older adults]," and "...surprisingly, there are almost no studies of elderly readers in the document design literature (507)."

In *User interface design for older adults* J. M. Morris wrote "The lack of knowledge of older adults can produce false intuitions for even the most expert designers...the state of designer awareness implies that there is a need to collect and organize characteristics and recommendations from existing sources, and present them in a form understandable to anyone who is interested in designing for a population that includes older adults (375)."

4 For a discussion of sources of bias in design education, see Dietmar Winkler's discussion in *User-centered graphic design* (1997).

5 David Sless discusses the difficulty that people often have articulating their impressions of the visual features of products (Sless, 1996). He writes, "they make comments about the improved versions, such as 'it looks professional,' 'it's easy to read,' or 'it's nice to look at' which gives a sense of something underlying what is articulated (259)." We hoped to generate a more explicit and actionable dialogue in our sessions through use of the compare-and-contrast discussion approach.

6 The imperative of dynamic "white space" in composition as taught at the Bauhaus and as discussed by Jan Tschichold in *Die neue Typographie*, 1928, (published in English in 1995 as *The New Typography* with translation by Ruari McLean) has had tremendous influence during the twentieth century on the assumptions designers have brought to tasks involving typography. The high value placed on dynamic page composition in graphic design education and practice has biased designers toward use of smaller type faces as a means of preserving white space and creating finer textures in settings of text. This orientation is at odds with older adult's requirements for information retrieval generally, but it is especially problematic in computer environments where screen space is limited.

7 The word unanimous is used in this paper when a majority of the participants in both groups expressed verbal agreement with an idea and no opposition was voiced. However, because of the social aspects of the group environment, it has to be assumed some opposing views may have gone unvoiced.

8 Tschichold's discussion of capitalization in *The New Typography*, (1995, 78) is characteristic of the modernist preference for lower case headings.

9 In *A Primer of Visual Literacy* (1986), Donis A. Dondis uses rhetoric inherited from Bauhaus masters Josef Albers and Johannes Itten to discuss color contrasts. "Saturated color is simple, almost primitive, and always given preference by folk artists and children...the less saturated colors reach toward neutrality of color, even non-color, and are subtle and restful (51)." The effect of this pedagogy, although useful for describing color harmonies, has produced an orientation among designers to use subtle color contrasts that may be difficult for older adults to discriminate.

10 The hues used for text and heads in the final program as created in the Adobe Illustrator 7.0 program were: dark red brown: C46, M65, Y70, K75 and dark teal: C100, M65, Y65, K60. The warm blue background was C48, M28, Y20, K0.

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Patricia Neafsey holds an M.S. in nutritional biochemistry from Cornell University, a Ph.D in Pharmaceutical Science from the University of Connecticut, and completed post-doctoral work at Tufts University. She has authored numerous papers on nutrition, pharmacology and the use of interactive computer technology in nursing education and patient dose risk reduction. Recent work involves research collaboration to measure the effectiveness of an interactive, animated educational software program for reducing high-risk self-medication behaviors in older adults.

■ The research team

The research team reflects the interdisciplinary nature of the problem. Patricia Neafsey, Ph.D. (pharmacology), heads the project as principal investigator. Design collaborator, Zoe Strickler, M.Des. (visual communication design), directed the visual communication research and design and production of the animations. Collaborators Robin H. Froman, Ph.D. (educational psychology), and Steven V. Owen , Ph.D. (educational psychology), provided guidance for development of the measurement instruments and will contribute statistical analysis for the clinical trial. Doctoral nursing student Juliette Shelman, assisted by honors nursing student Antoinette Padula, lead the qualitative language prestudy for design of measurement instruments and the program. She is also directing the field nurses who are implementing the clinical trial. Design students Michael Skiles and Mai Phung contributed design of prototypes for the formative research phase. Design students Amy Ellingham, Sam Kim, and Meena Stout provided production assistance for segments of the PEP.