Communicating Medical Information Through Pictograms:

A Case Study for Type II Diabetes Quality Measures

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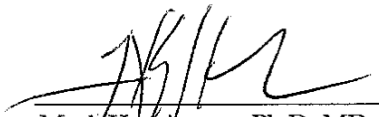

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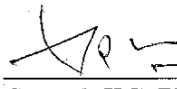

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TABLE OF CONTENTS

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ABSTRACT

Visual health information is most commonly portrayed through the written word. This limits accessibility of the information to people with moderate literacy. The goal of this research is to see how the emphasis of user-centered visual communication can aid the exchange and understanding of healthcare information. This research uses a qualitative method through literature review, market research, survey collection, and personal observation. Research in the fields of visual literacy, health literacy, UX, UI, and HCI are employed as defense for decisions made during the design process.

The ending result is a project branded *Signifi* in which six quality measures for diabetes were transformed into pictographic representations. Feedback to the pictograms and their application were gathered over the course of one week at a public installation. The findings assert the need for a greater emphasis on visual communication in situations where medical information is exchanged.

INTRODUCTION

From the waiting room to the exam room, to the setting of patients' everyday lives– accessible information is limited as communication is traditionally the written or spoken word. This problem is consistent with print media as well, leading to an overall unpleasant visual experience. Beyond basic patient information, medical terminology used to determine the patient's pre-existing conditions and family health history require intermediate health literacy.

Reliance on text limits patients' abilities to visualize their health information in a way that fits their cognitive and emotional needs. How patients perceive the quality of doctor-patient communication is directly correlated to patient satisfaction (Chen et al.), emotional state (Stewart et al.), and manageability of chronic disease (Kaplan, Greenfield and Ware; Fallowfield and Jenkins). Poor health literacy combined with a growing population of persons suffering from chronic disease, present the subject of visual health information communication as a compelling topic for design research.

Americans' ability to prevent and manage disease relies on their ability to make sense of the info they hear, read and see by providers, educators, and the media (Institute of Medicine Committee on Health; Kutner et al.; Rudd et al.). While many factors affect an individual's health literacy, visual communication for health information exchange may be the solution to a higher health literate population that makes better, more informed health decisions.

Visual aids have been scientifically proven to benefit patient education (Friedman et al.) and quality of communication (P. S. Houts et al.), overcoming barriers such as

differences in culture (Booth and Robinson), age (Stewart et al.), language (Taylor and Jones; Lee), and personality (Franks et al.). Additional studies have determined pictograms are directly related to higher (Kakkilaya et al.) and more accurate recollection rates of patients (Garcia-Retamero and Hoffrage; Peter S. Houts, Rebecca Bachrach, et al.; Peter S. Houts, Judith T. Witmer, et al.) leading to better adherence of self-treatment instructions (Dowse and Ehlers). Pictograms have also been proven effective through patients' increased ability to understand medical conditions (Garcia-Retamero, Cokely and Hoffrage) and assess the risk-benefit of prescription medications (Hallgreen et al.); thus enabling more informed decisions when it comes to healthcare (Lenz et al.).

Not only can health information difficult to understand, it is equally as difficult to visualize. The majority of information exchanged within the conversation of disease prevention and management is abstract, eliminating any possibility for accessible representational imagery. From symptom reporting to prognosis, there are no guidelines for successfully visualizing medical information for the prevention and care of chronic disease. The development and adherence to standardization guidelines for healthcare information visualization would increase the instances and consistency of exposure, resulting in better recognition.(Jensen and Bossen) Better recognition of medical terms amongst the general population has the potential to increase health literacy thus, decreasing the instances of chronic diseases such as Type II Diabetes and the costs associated with it.

Health Information Technology

Technology has changed how we communicate and healthcare is no exception. The adoption of technology and emphasis of patient involvement has introduced new opportunities for

patients to obtain, process, and understand health information and services (Health et al.; Institute of Medicine Committee on Health; Rasu et al.). While health information technology (HIT) improves ability to access and exchange information, it has introduced new cognitive challenges that directly impact patients' ability to process and understand information when issues of health literacy already exist. The effectiveness of information exchange depends on many factors. Relying solely on verbal and gestural communication for patient care continues to undermine improved accessibility (Franks et al.). This results in lost time, money, and other valuable resources for patients and healthcare providers alike (Rasu et al.). Much improvement is needed to adapt the patient-provider experience to changing technology and preferred communication styles.

While users' basic needs for functionality are being met, interviews with professionals in healthcare have confirmed a general dissatisfaction towards the graphic user interface. The general consensus was that electronic health records (EHR) are efficient in managing patient data. However, many are lacking the clinical perspective.(Friedberg et al.; Edsall and Adler) This may be partially due to the difficulty of visualizing healthcare information and the lack of resources guiding the development of doing so. Situations such as these often force software developers to default to the next best form of visual communication, which is text.

Advancing HIT has the potential to improve accessibility. However, software development process historically allocates a small amount of time and resources to the design and testing of graphic user interface (GUI). A standardized series of visualizations may decrease the need for design and testing. The decreased need for design and testing may shorten development time while producing higher quality results. Additionally, it would

allow designers and developers to take the guesswork out of which pictograms result in easier implementation and increased health literacy across patients who are in contact with HIT over time.

METHODOLOGY

This research uses a qualitative method through literature review, market research, and personal observation. Said methods were used to determine the status quo of health information visualization standards and delivery methods. Topics including visual literacy, health literacy, user experience (UX), graphic user interface, (GUI), and human computer interaction (HCI) were included within the literature review.

Semi-structured interviews with three family medicine physicians determined the need for additional research and implementation recommendations. Additionally, their expressed opinions and perspective clearly demonstrated users' frustrations with the graphic user interface and overall interaction. This reaction is not an isolated phenomenon. Research demonstrates patients and physicians are able to complete necessary tasks although agreeing EHR interface is more business focused and fails to intuitively follow the clinical process (Lau et al.).

When deciding which area of medicine would benefit most from this research, chronic disease provided the greatest potential for significant impact. When caring for a chronic disease, patients and healthcare providers are required to share complex information and knowledge at high rates (Yair and George). *Signifi* will use the condition of Type II Diabetes for demonstration and serve as an example for future expansions. The author and advisors to this research also determined Type II Diabetes a good subject with the understanding that while certain populations are at higher risk, chronic disease does not discriminate.

Type II Diabetes is the leading cause of kidney failure, lower-limb amputations (other than those caused by injury) and new cases of blindness among adults. Patients of Type II Diabetes also meet with their physicians to manage their care more often than other patient groups, allowing for greater opportunities to gather data in the future (Prevention).

The success of the proposed pictograms as a standardized series relies on interpretation by both patient and physician, thus it is imperative that feedback from each is leveraged throughout the design process. Given these challenges, a participatory approach to the design of the pictograms will be taken.

Designers have successfully developed icons/pictograms using a participatory approach, which gathers input from patients and health care professionals (Salman, Cheng and Patterson; Choi). However, this approach has yet to be integrated with additional design research for establishing recommendations towards an expandable and adaptable, series of pictograms for applications in both print and digital media.

To gather participation *Signifi* utilized print surveys. Feedback collected from participants included a series of multiple choice questions on a five-point Likert scale and open-ended questions. The first component gathered the user groups' demographics and health literacy (fig A.1, A.2).

In the survey participants were also asked to provide their response to the traditional EHR display. Results from this data set titled *Quality of Experience* demonstrated the users' general viewing pleasure compared to *Signifi* (fig A.3). Results validate findings from previous research, further demonstrating the need for adherence to graphic best practices and an emphasis of user-centered design.

Signifi asked participants to draw symbolic interpretations of medical terminology used in the prevention and management of Type II Diabetes (fig A.4). The six terms were quality measures for Type II Diabetes including 1) Eye exam; 2) Lipid management; 3) Foot exam; 4) Blood pressure; 5) HbA1c testing and management; and 6) Urine protein. Results from this component were used to determine the most common interpretation, which in return gave insight to the design process.

Lastly, participants visibility and interpretation preferences were measured through their rating of images from one to four with one being the best and four being the worst. These ratings were based on three different categories: 1) figure and ground (fig A.5); 2) text image orientation (fig. A.6); and 3) level of abstraction (fig. A.7). While survey findings informed design process for the pictograms, case studies regarding best practices, visualization classification, and principles of effective information visualization were also instrumental.

The pictograms based on the survey results were incorporated into a simple prototype for a patient education application. On April 11, 2016 an installation revealed the research and results to the public. For the duration of one week the research was displayed as an installation in Vermillion, South Dakota at the University of South Dakota John A. Day Gallery. The installation employed one third of the gallery space and utilized the full length of a 60 foot wall.

The week-long installation and closing reception on April 15, 2016 was used as an opportunity to 1) visualize the research; 2) collect additional surveys; and 4) measure public opinion to the general research theme, the pictograms themselves and their real-life

application. Findings from the installation were incorporated into the final product and will be discussed in the Findings and Design chapters of this paper.

Survey Method

The International Research Board at the University of South Dakota granted permission to deliver and collect surveys contingent on participants' informed consent. The objective was to gather feedback from a variety of participants with age being the only requirement. Participants verified they were of 18 years of age or older during the time of the survey.

Participants were asked to answer a total of 30 questions which broke into five different categories of information: **1**) demographics; **2**) health literacy; **3**) perceived satisfaction; **4**) visual preferences; and **5**) participation. Information provided by the subjects will determine the need for pictograms in the primary care setting as well as supply data necessary for user-centered design.

FINDINGS

Demographics

The user group consisted of 60 volunteers. 55% of the 60 participants were female (33) and 45% were male (27). 61% of participants were in the 18-24 age group (37); 18% of participants were in the 25-34 age group (11); 10% of participants were in the 45-64 age group (6) 8% of participants were in the 35-44 age group (5); and; 2% of participants were in the 64+ age group (1).

48% of participants had some college experience but no degree (29); 22% of participants had a Bachelor's degree (13); 12% of participants had a high school diploma or GED (7); 10% of participants had a Graduate or Master's degree (6); 7% had an Associate degree (4).

75% of participants identified themselves as white (45); 7% of participants identified themselves as Asian (4); 7% of participants identified themselves as multiple races (4); 3% of participants identified themselves as black (2); 3% of participants identified themselves as Native American (2) and; 2% of participants did not identify their race (2).

Each category of these demographics is representational of the campus population where the surveys took place. Future research would expand to reach a broader range of participants; particularly minority populations where communicating health information can be most difficult (Kutner et al.).

Health literacy

Due to the necessary audience participation, it was important to limit the number of questions and time required to complete the survey. Due to these constraints, Patients were asked questions adapted from the study titled *Brief questions to identify patients with inadequate health literacy* by Chew et al. This method developed in 2006 was found effective in detecting limited health literacy.

Question 1: *I am confident filling out medical forms by myself* (fig. C.1). 55% said that they are *almost always* confident filling out medical forms by themselves (33); 32% said that they are *sometimes* confident filling out forms (19); 7% said they are confident *rarely* (4) 5% said they are confident *every once in a while* (3) and; 2% said they are *never* confident filling out medical forms by themselves (1).

Question 2: *I have someone help me read medical materials* (fig. C.2). 30% said that they *sometimes* have someone help them (18); 23% said that they *almost always* have someone help them read medical materials (14); 18% said they *rarely* have someone help them (11); 17% said they have someone help *once in a while* (10); and 12% said they *never* have someone help them read medical materials (7).

Question 3: *I understand medical terms used when speaking with my physician* (fig. C.3). 53% of participants said that they *sometimes* understand (32); 35% said that they *almost always* understand medical terms used when speaking with their physician (21); 5% said they understand terms *once in a while* (3); 3% said they *rarely* understand medical terms (2) and; 1% said they *never* understand (1).

Quality of experience

The survey states the following: *Please complete the following questions in reference the copy of the electronic health record (EHR) that can be found on the opposite side of the consent form included with this survey.*

Question 1: *Your overall response to the design* (fig. D.1). 28% of participants were very satisfied (17); 28% said they were satisfied with the design (17); 23% were somewhat satisfied with the design (14); 12% were unsatisfied with the design (7) and; 8% said they were very unsatisfied with the design (5). Overall, over half of participants said they were satisfied or very satisfied in their overall response to the design.

Question 2: *Your ability to navigate the information* (fig. D.2). 28% of participants were very satisfied (17); 38% said they were satisfied with their ability to navigate the information (23); 17% were somewhat satisfied with their ability to navigate (10); 10% were unsatisfied with their ability (6) and; 7% said they were very unsatisfied with their ability (4). Overall, over half of participants said they were satisfied or very satisfied in their ability to navigate the information.

Question 3: *Your ability to view the information* (fig. D.3). 23% of participants were very satisfied (14); 25% said they were satisfied with their ability to view the information (25); 22% were somewhat satisfied with their ability (13); 23% were unsatisfied with their ability (14) and; 7% said they were very unsatisfied with their ability to view the information (4).

Question 4: *Your ability to understand how the information is organized* (fig. D.4). 27% of participants were very satisfied (16); 35% said they were satisfied with their ability to navigate the information (21); 27% were somewhat satisfied with their ability to navigate (16); 7% were unsatisfied with their ability (5) and; 4% said they were very unsatisfied with their ability (3). Overall, over half of participants said they were satisfied or very satisfied in their ability to navigate the information.

Question 4: *Your ability to understand how the information is organized* (fig. 4.4). 27% of participants were very satisfied (16); 35% said they were satisfied with their ability to navigate the information (21); 27% were somewhat satisfied with their ability to navigate (16); 7% were unsatisfied with their ability (5) and; 4% said they were very unsatisfied with their ability (3). Overall, over half of participants said they were satisfied or very satisfied in their ability to navigate the information.

Question 5: *Your ability to understand the language used* (fig. D.5). 44% of participants were very satisfied (26); 28% said they were satisfied with their ability to navigate the information (17); 15% were somewhat satisfied with their ability to navigate (9); 8% were unsatisfied with their ability (5) and; 5% said they were very unsatisfied with their ability (3). Overall, over half of participants said they were satisfied or very satisfied in their ability to navigate the information.

Nearly half of the participants in each instance were either satisfied or very satisfied with their ability to view and navigate the information. Same can be said for the participants' ability to understand the language used and the organization of the information. This was also translated into the participants overall response to the design. While this information

may be representative of participants, it is not an accurate depiction of the environment where such information would be encountered. Also, the questions were related to a single interface design. Lastly, the EHR was demonstrated through print although it traditionally would be displayed digitally.

Visual Preferences

FIGURE AND GROUND

Gestalt's principle of figure/ground describes the eye's tendency to see and separate objects from their surroundings. Our mind separates the visual field into the figure (the foreground) and the scene (the background). It is important to establish balance between the negative and positive space or clearly distinct the two (Arnheim). To establish which stable relationship between figure/ground was most effective, participants were asked to rate their preference from one to four with one being the best and four the worst.

Solid illuminated figure on high-density background (fig 5.1) was the first choice for 36% of participants (19), the second choice for 38% of participants (20), third choice for 13% of participants (7), and fourth for 13% of participants (7). *Outlined figure on low-density background* (fig E.2) was the first choice for 42% of participants (22), the second choice for 28% of participants (15), third choice for 25% of participants (13), and fourth for 5% of participants (3).

Reverse outlined figure on high-density background (fig E.3) was the fourth choice for 55% of participants (29), the third choice for 32% of participants (17), second choice for 8% of participants (4), and first choice for 6% of participants (3). *Solid figure on low-density background* (fig E.4) was the fourth choice for 28% of participants (15), the third choice for 30% of participants (16), second choice for 26% of participants (14), and first choice for 17% of participants (9).

LEVEL OF ABSTRACTION

Results from the *abstraction* section displayed the participants overall preference for more detailed imagery. 50% of participants stated the pictogram with abstract detail was their

preferred representation (fig E.5). 45% of participants chose the most detailed version as their preferred level of abstraction (fig E.6). The most abstract pictogram (fig E.7), and the second to most abstract pictogram (fig E.8) were the least preferred levels of abstraction.

ORIENTATION

Horizontal with pictogram on the left (fig. E.9) 34% thought it was the best (18); 28% found it the third best (15); 23% found it the second best (12); and 15% found it to be the worst (8). 60% found *horizontal orientation with the pictogram on the right to be the worst* (32) (fig. E.12); 19% found it the third best (10); 17% found it the second best (9); and 4% thought it was the worst (2). *Vertical with pictogram on the bottom* (fig. E.10) was thought to be the best by 32% participants (17); 17% found it the second best (9); 34% found it the third best (18); and 17% found it to be the worst (9). Lastly, *the vertical orientation with the pictogram above the identifying text* (fig.E.11) was thought to be the best by 30% (16); 43% found it the second best (23); 19% found it the third best (10); and 8% found it to be the worst (4).

Survey results demonstrated that participants preferred a vertical relationship between the pictogram and identifying text with the imagery above. The second preferred relationship was horizontal with the pictogram on the left displayed with a centered vertical alignment to the text. Both of these methods were used in the application of the icons. The vertical alignment is show in the educational application, where size was a dictating factor. The horizontal arrangement can be seen in the installation graphics and the EHR prototype (fig G.1-G.9). In the process, this designer found the horizontal orientation to be beneficial when working with smaller space and consistent with the natural reading direction of left to right.

Participation

Prior to designing the pictograms, each of these surveys was analyzed to establish which object or idea was most commonly represented. Each of the surveys were scanned, placed into a database, and then separated into the six different quality measures: eye exam (fig F.1); foot exam (fig F.2); urine protein (fig F.3); HbA1c *or blood sugar* (fig F.4); lipid management or *cholesterol* (fig. F.5) and; blood pressure (fig F.6). While each drawing was unique, some patterns were found. Groups with similar qualities were tallied to determine the final object or idea represented in the pictogram (fig F.7).

DESIGN

Three practical applications were created for demonstrating how the pictograms would be utilized in real-life application. While survey participants drove the concept development for the pictograms, digital media design was driven by research in the fields of GUI, and information visualization.

Digital design can be discussed from the view of gestalt and design principles as well as *Principles of Effective Visual Communication for Graphical User Interface Design*. I will be referring to consideration of the design based off of the principles of 1) organization; 2) economy; and 3) communication. Organization is created through the consistency of information, the screen layout (grid), the relationship between elements, and overall navigability.

Economize is the practice of communicating a message with as little information necessary to reach the user. I found communication was of greatest consideration due to the nature of this project. Legibility, readability, typography, color/texture, and accessibility from multiple views were all components taken into consideration when designing both the digital and print materials.

Color

Color can be discussed in multiple terms as well as different ways as seen by research from scientists, artists, designers, programmers, and human psychology. For the purpose of this research, color decisions were also made in adherence to principles of organization, economy, and communication (Aaron). Color benefits design as an attention getter, information grouper, and value assigner. However, ineffectively using color can reduce functionality. Also

colors change according to displays, lighting – fluorescent, incandescent, or daylight (Murch). Taking these factors into consideration, minimal colors were used.

Psychology research has proven blue and green is the most relaxing colors, thus most often used in the healthcare setting (Birren). With this in consideration; the icons, each of their applications, as well as the installation were designed in black and white with blue-green as a supplementary color. The blue and green spectrum is (RGB: 39,189,190). Its brightness level is high which allows it great flexibility for alternative variations while also providing great contrast between as well as black and white. Additionally, older viewers need higher brightness levels to distinguish color (Murch).

In instances were more differentiation was necessary due to an abundance of information (see figures G.2 through G.4.) a complimentary color to the blue-green was chosen for contrast. Studies in color theory confirm that the use of secondary colors is pleasing to the eye while enabling strong contrast in both value and chroma. Additionally, blue and yellow are good peripheral colors allowing for greater accessibility (Murch).

Typography

According to these principles defined by Marcus along with best practices in the field of design, recommended number of typefaces is limited to a maximum of three with three different font sizes. For legibility purposes, serif fonts are typically preferred over other classifications due to the distinctiveness between different letterforms. With this in mind the type family chosen for use in print media was *Caecillia* in both the light and bold weights. Categories of information were established through three different sizes along with

capitalization, italicization, and color. *Caecillia* by classification is a slab serif style. However, the variety of line weight and variety of weights offered in this type family enables its ability to function effectively as both a display heading and as body copy. Established natural reading patterns informed the right alignment of the text with deviations occurring rarely to accentuate the importance of information. Lines of text in digital format were limited in 40-60 characters per line whereas print was limited to the 50-75 characters per line range. Type sizes were informed by usability guides found in *Simply Put* and can be seen in figures G.1 through G.6.

Mockups of the final designs were created to demonstrate ways in which this research may be applied. Figure G.5 shows a man holding a tablet outside of the medical setting whereas figures G.6 and G.7 show the application functioning within the setting of a medical exam room.

CONCLUSION AND RECOMMENDATIONS

Limitations that may have impacted results of the study include the geographically isolated area and the validity of survey responses. The information regarding the current status of EHR interface was based on screenshots provided by local hospitals that volunteered to participate in this research. This information is unavailable for demonstration due to copyright and privacy issues. Additionally, surveys were focused on information exchanged when using common terms to discuss Type II Diabetes. This case study should be expanded to include the treatment of additional chronic diseases and alternative environments such as acute and emergency care.

Proposed benefits of standardized medical information through pictograms include increased information management, access to health services, quality and safety of care, continuity of services, and cost containment. Further refinement to the research method and additional design process will be necessary to produce more scientifically reliable data.

Overall, the feedback from to the research and design was positive. Findings verify the preference of visual aids when exchanging medical information. Future research based on a higher functioning prototype is necessary for further testing in accessibility and learnability. Future research may use alternative platforms for survey participation. Crowd sourcing has proven beneficial in the participatory design process and is successful in gathering a diverse user group. A more controlled, longitudinal study is necessary to validate the predictions of these potential outcomes.

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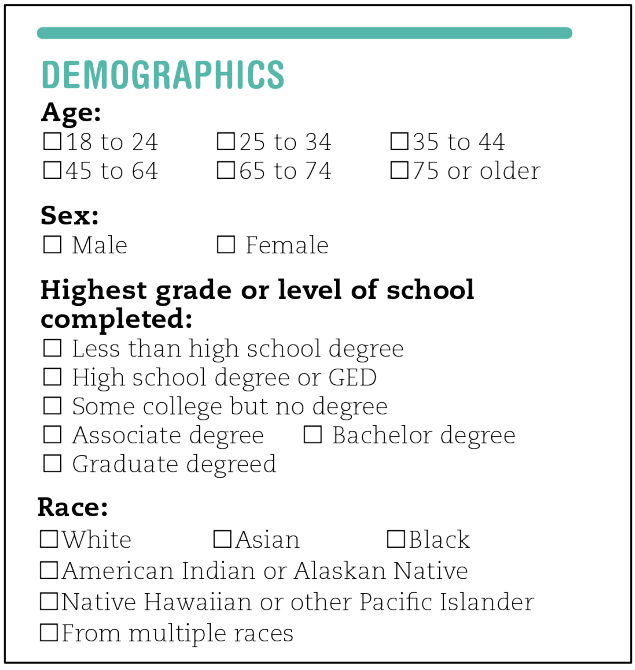
APPENDIX A: SURVEY DESIGN



DEMOGRAPHICS

Age:

☐18 to 24 ☐25 to 34 ☐35 to 44
☐45 to 64 ☐65 to 74 ☐75 or older

Sex:

☐ Male ☐ Female

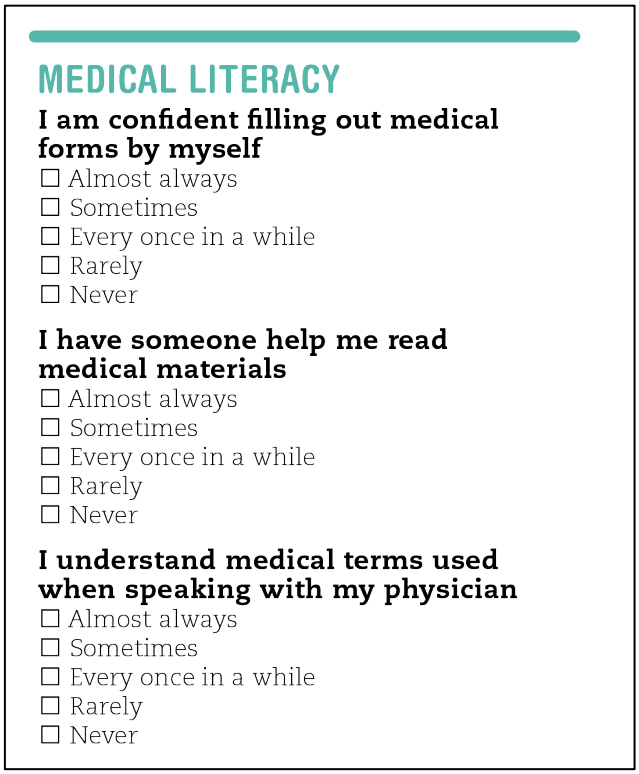
Highest grade or level of school completed:

☐ Less than high school degree
☐ High school degree or GED
☐ Some college but no degree
☐ Associate degree ☐ Bachelor degree
☐ Graduate degreed

Race:

☐White ☐Asian ☐Black
☐American Indian or Alaskan Native
☐Native Hawaiian or other Pacific Islander
☐From multiple races

Fig. A.1: 'Demographics' Survey Questions for *Signifi*; 2016.



MEDICAL LITERACY

I am confident filling out medical forms by myself

☐ Almost always
☐ Sometimes
☐ Every once in a while
☐ Rarely
☐ Never

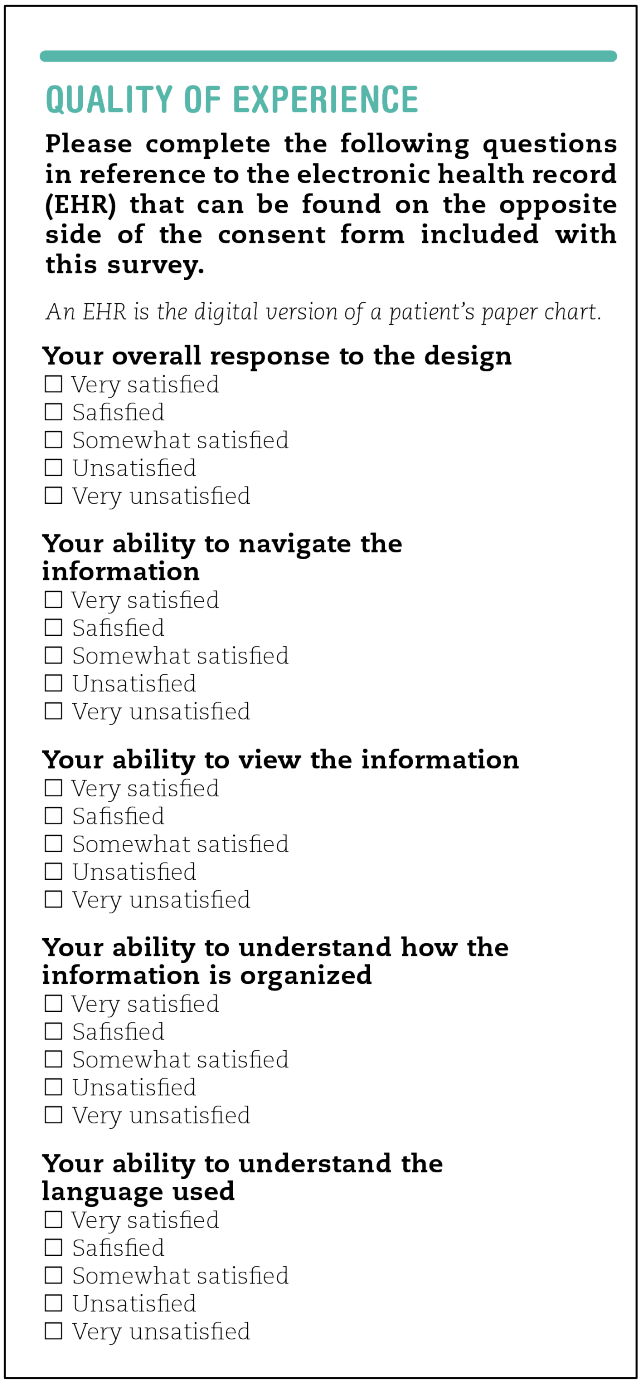
I have someone help me read medical materials

☐ Almost always
☐ Sometimes
☐ Every once in a while
☐ Rarely
☐ Never

I understand medical terms used when speaking with my physician

☐ Almost always
☐ Sometimes
☐ Every once in a while
☐ Rarely
☐ Never

Fig. A.2: 'Medical Literacy' Survey Questions for *Signifi*; 2016.



QUALITY OF EXPERIENCE

Please complete the following questions in reference to the electronic health record (EHR) that can be found on the opposite side of the consent form included with this survey.

An EHR is the digital version of a patient's paper chart.

Your overall response to the design
☐ Very satisfied
☐ Safisfied
☐ Somewhat satisfied
☐ Unsatisfied
☐ Very unsatisfied

Your ability to navigate the information
☐ Very satisfied
☐ Safisfied
☐ Somewhat satisfied
☐ Unsatisfied
☐ Very unsatisfied

Your ability to view the information
☐ Very satisfied
☐ Safisfied
☐ Somewhat satisfied
☐ Unsatisfied
☐ Very unsatisfied

Your ability to understand how the information is organized
☐ Very satisfied
☐ Safisfied
☐ Somewhat satisfied
☐ Unsatisfied
☐ Very unsatisfied

Your ability to understand the language used
☐ Very satisfied
☐ Safisfied
☐ Somewhat satisfied
☐ Unsatisfied
☐ Very unsatisfied

Fig. A.3: 'Quality of Experience' Survey Questions for *Signifi*; 2016.

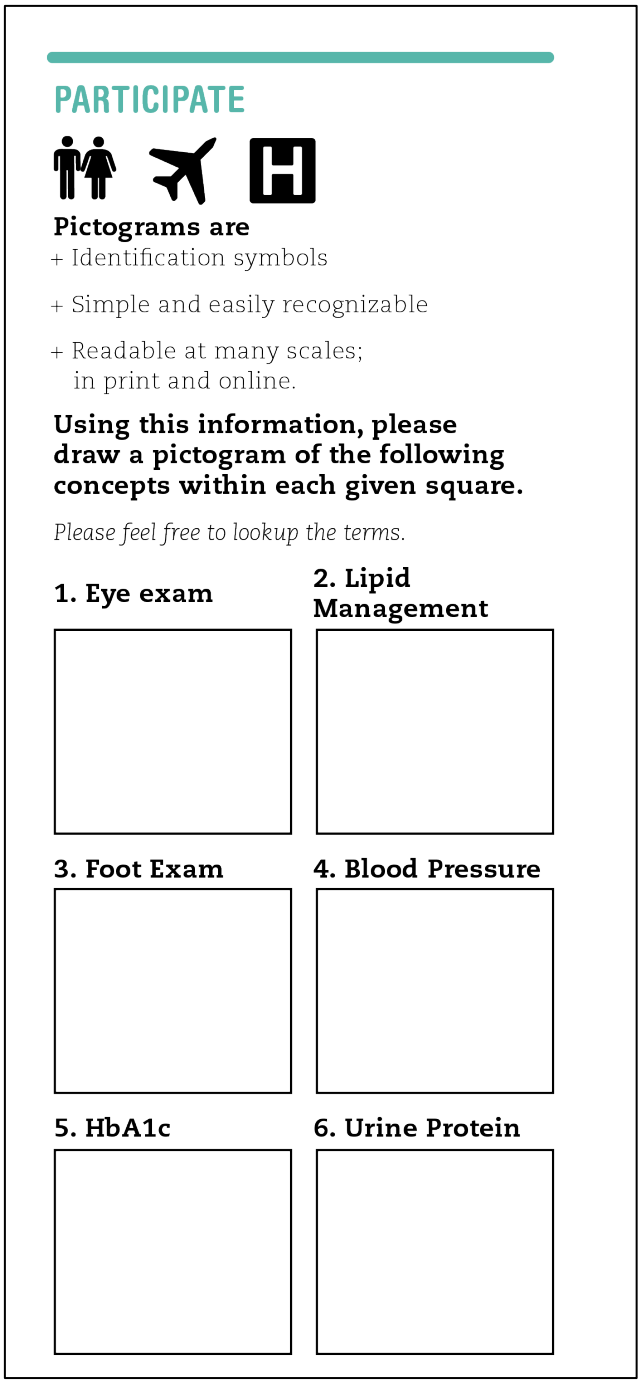


Fig. A.4: 'Participate' Survey Questions for *Signifi*; 2016.

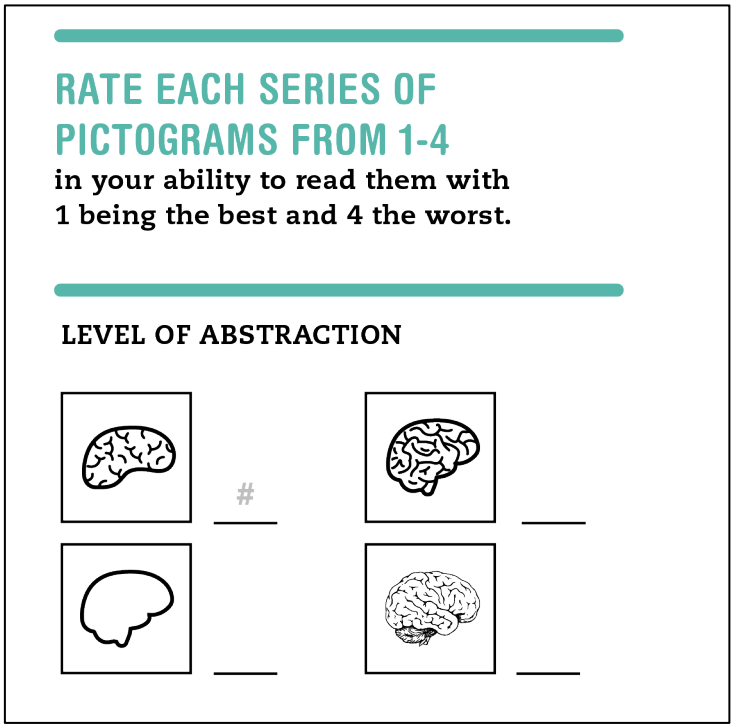


Fig. A.5: Level of Abstraction Survey Questions for *Signifi*; 2016.

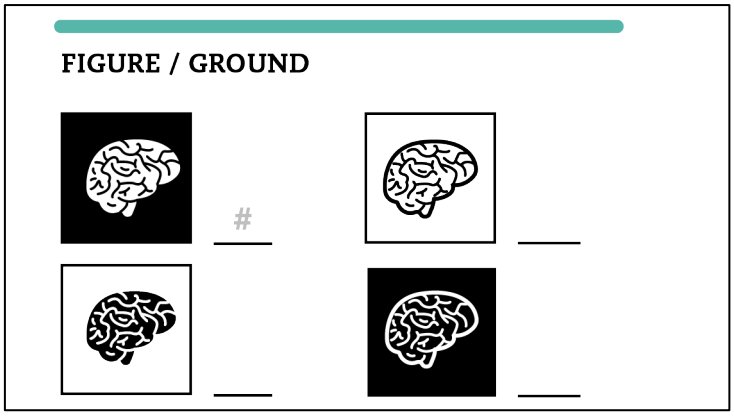


Fig. A.6: Figure Ground Survey Questions for *Signifi*; 2016.

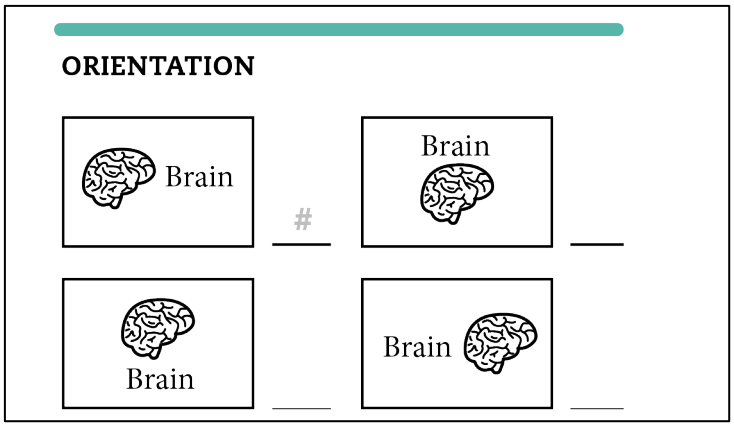


Fig. A.7: Orientation Survey Questions for *Signifi*; 2016.

APPENDIX B: DEMOGRAPHICS RESULTS

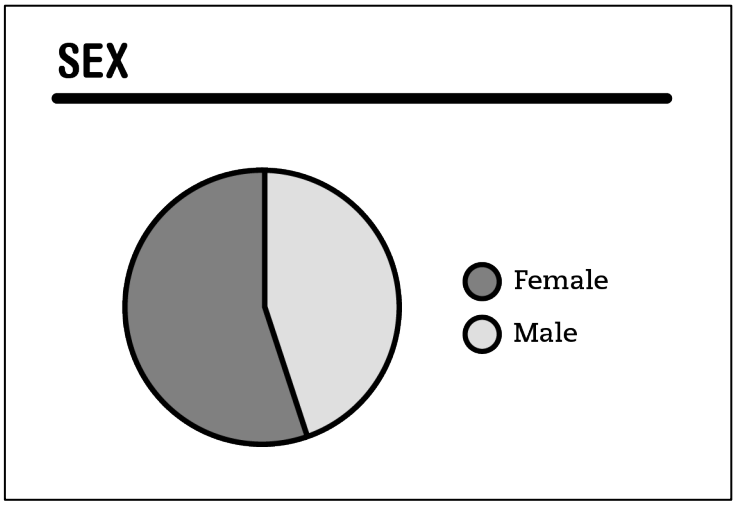


Fig. B.1: Demographics Survey Results of Sex for *Signifi*; 2016.

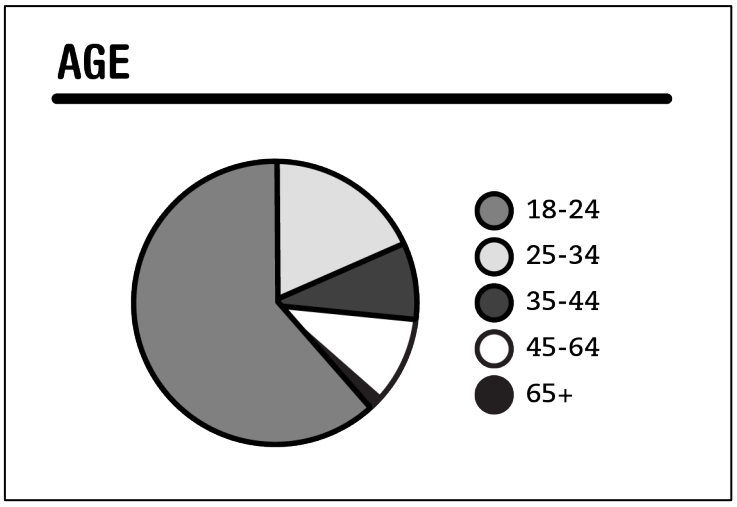


Fig. B.2: Demographics Survey Results of Age for *Signifi*; 2016.

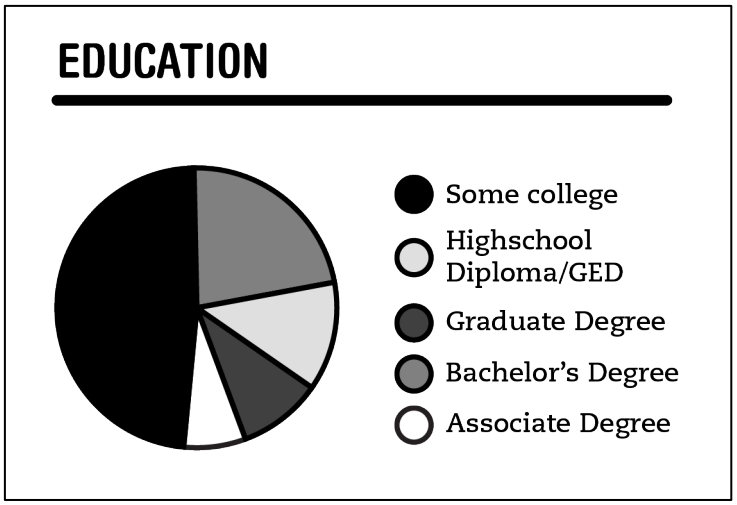


Fig. B.3: Demographics Survey Results of Education for *Signifi*; 2016.

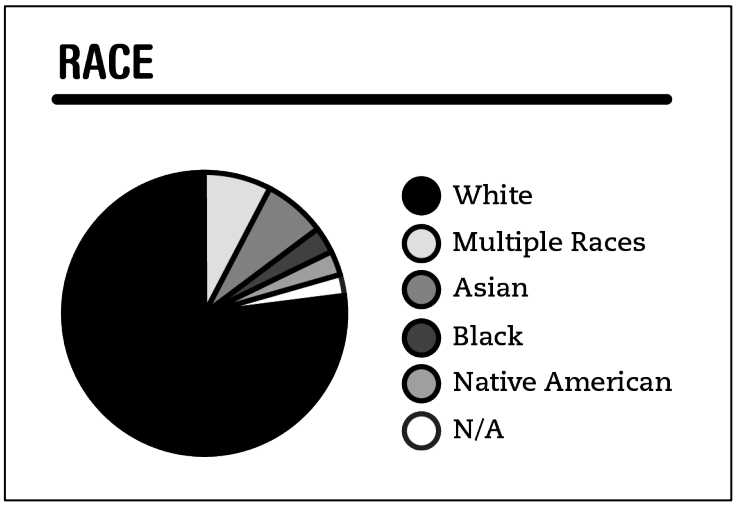


Fig. B.4: Demographics Survey Results of Race for *Signifi*; 2016.

APPENDIX C: HEALTH LITERACY RESULTS

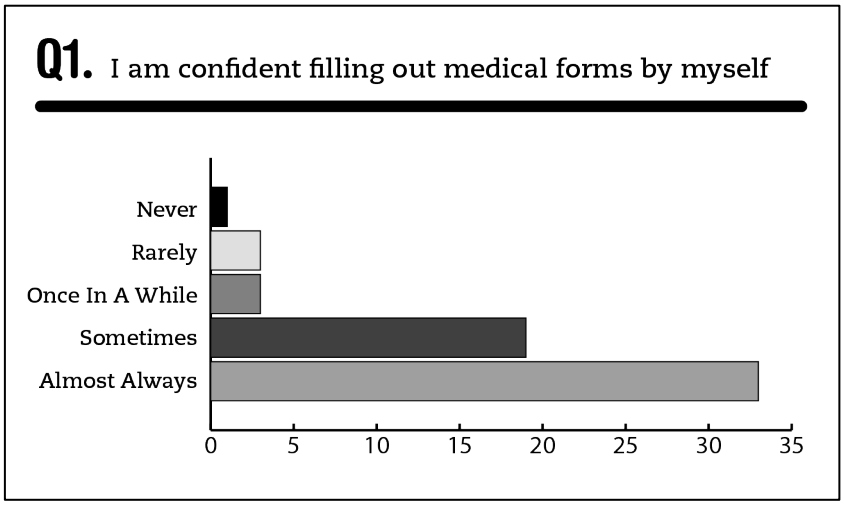


Fig. C.1 Survey Results of Medical Literacy, Question One for *Signifi*; 2016.

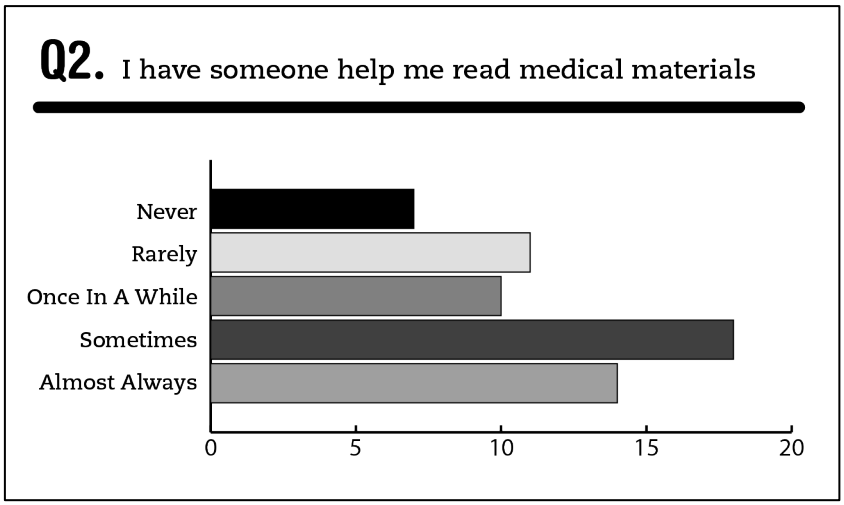


Fig. C.2: Survey Results of Medical Literacy, Question Two for *Signifi*; 2016.

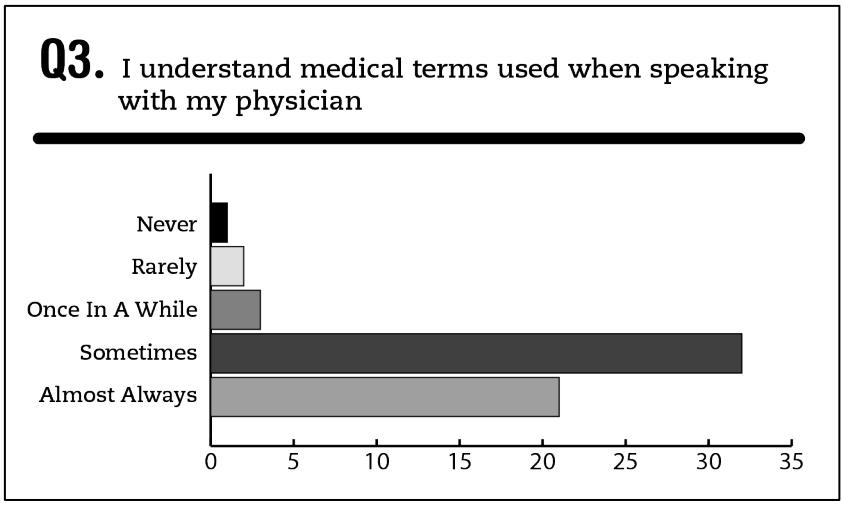


Fig. C.3: Survey Results of Medical Literacy, Question Three for *Signifi*; 2016.

APPENDIX D: QUALITY OF EXPERIENCE RESULTS

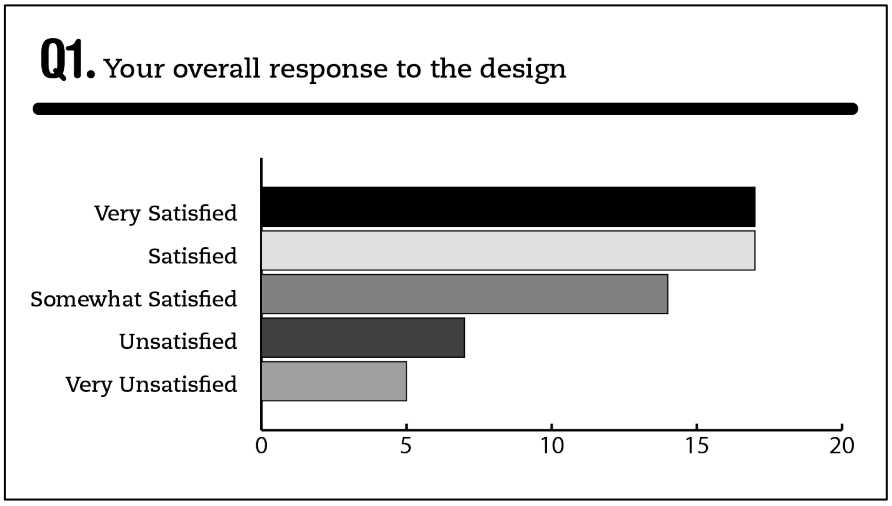


Fig. D.1: Survey Results of Quality of Experience, Question One for *Signifi*; 2016.

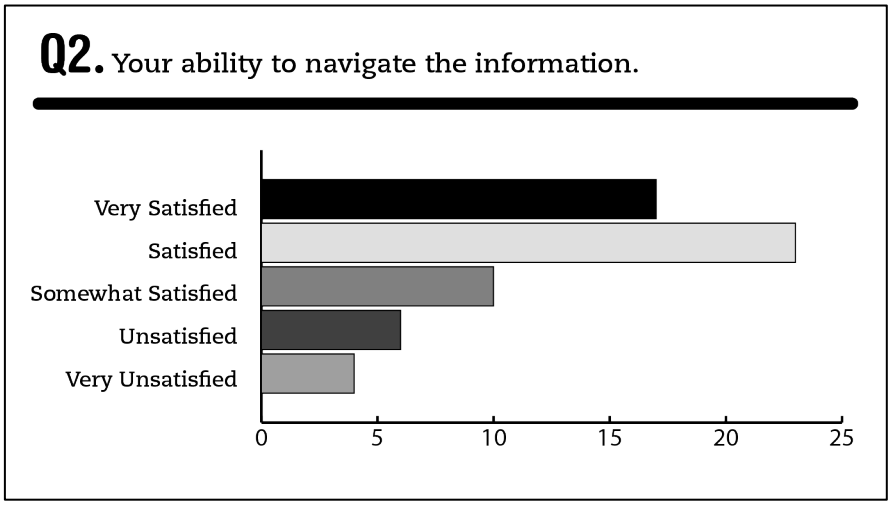


Fig. D.2: Survey Results of Medical Literacy, Question Two for *Signifi*; 2016.

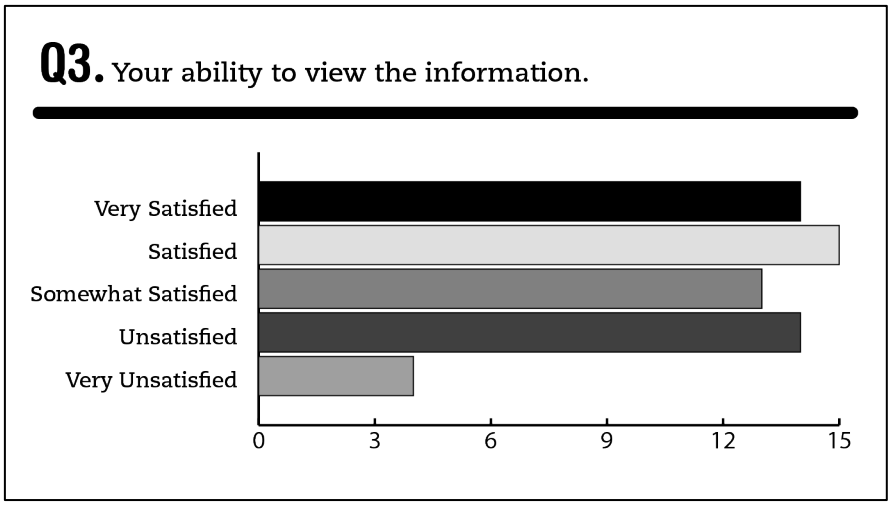


Fig. D.3: Quality of Experience Survey, Question Three for *Signifi*; 2016.

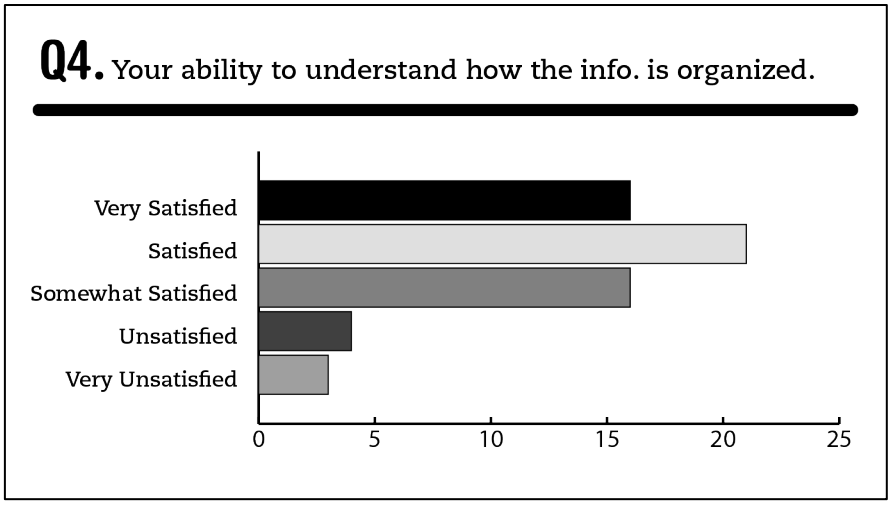


Fig. D.4: Quality of Experience , Question Four for *Signifi*; 2016.

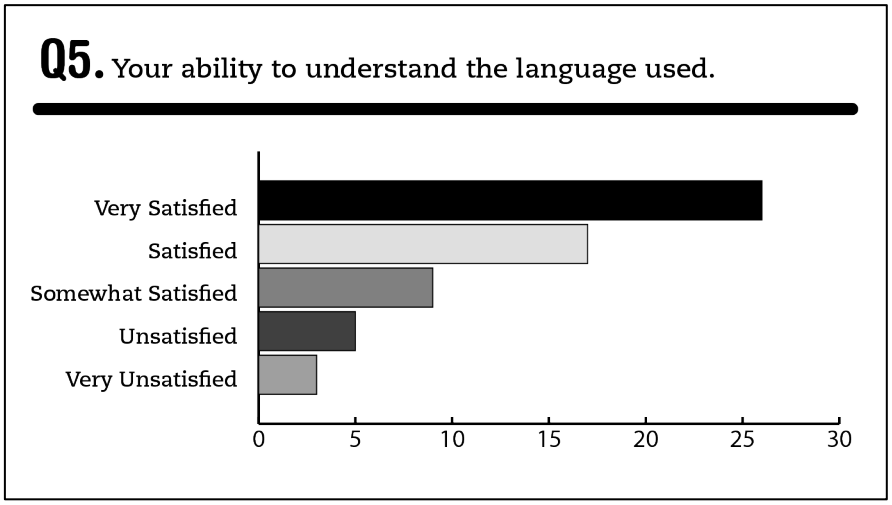


Fig. D.5: Quality of Experience , Question Four for *Signifi*; 2016.

APPENDIX E: VISUAL PREFERENCES RESULTS

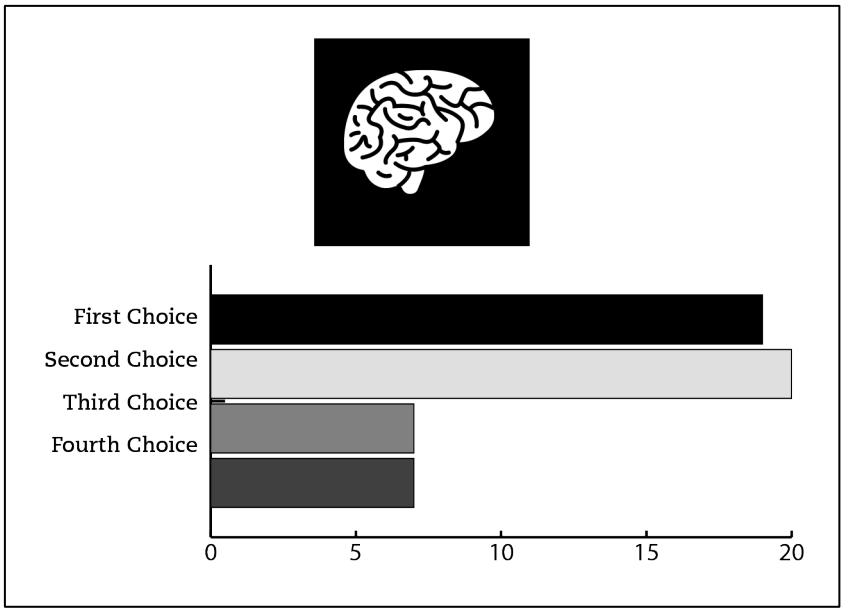


Fig. E.1: Solid Figure With High Density Background, Figure/Ground Visual Preferences Survey Question Answers for *Signifi*; 2016.

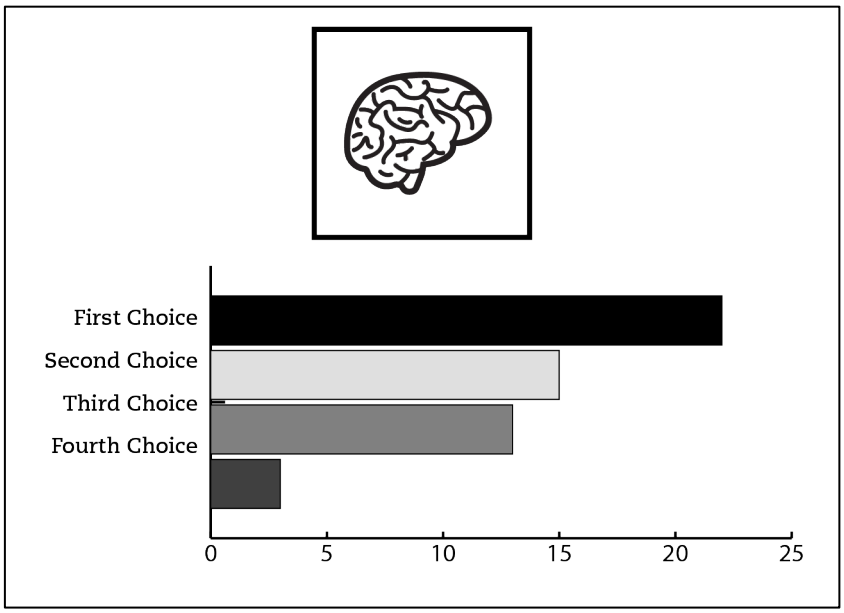


Fig. E.2: Outlined Figure With Low Density Background, Figure/Ground Visual Preferences Survey Question Answers for *Signifi*; 2016.

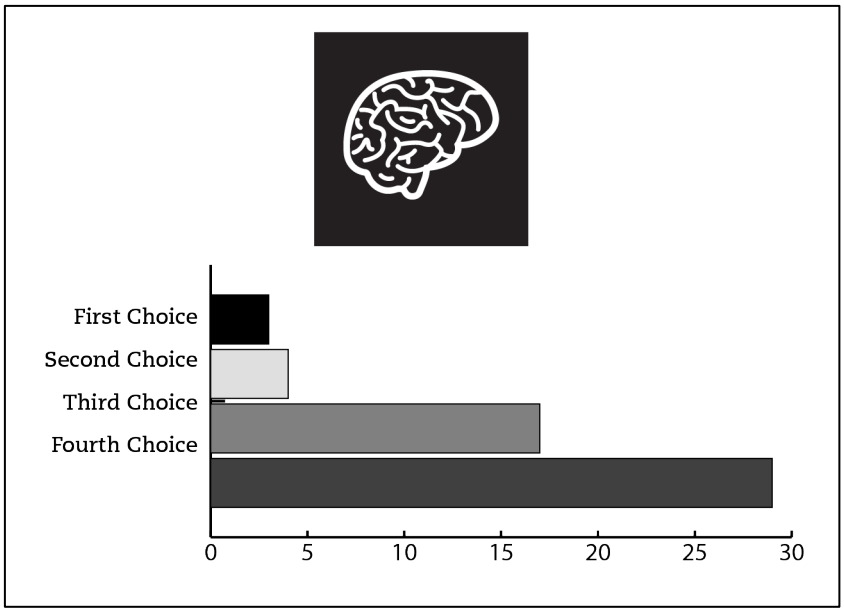


Fig. E.3: Outlined Figure With High Density Background, Figure/Ground Visual Preferences Survey Question Answers for *Signifi*; 2016.

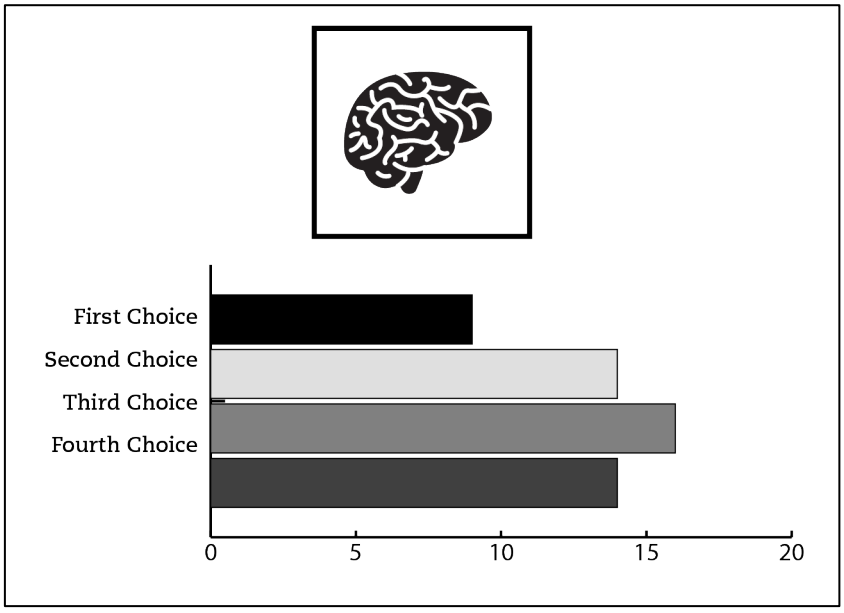


Fig. E.4: Solidy Figure With Low Density Background, Figure/Ground Visual Preferences Survey Question Answers for *Signifi*; 2016.

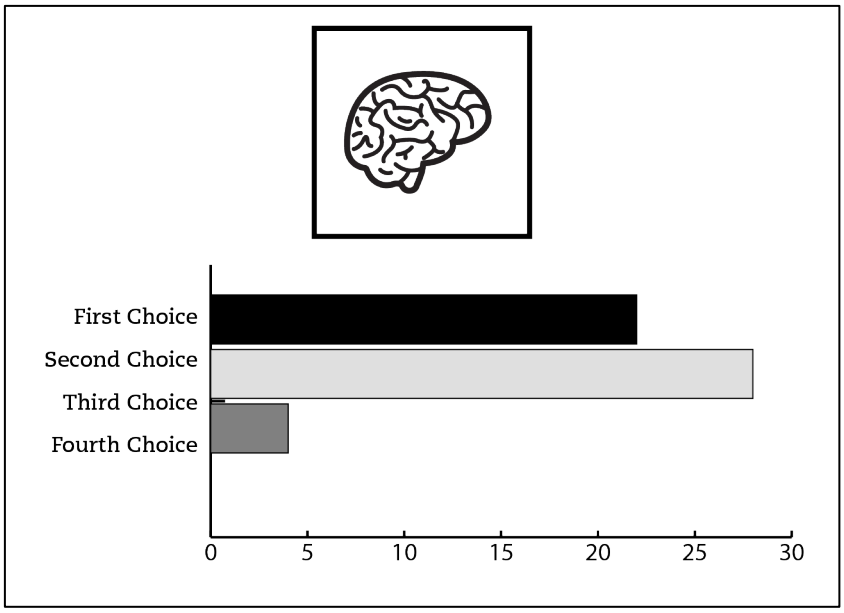


Fig. E.5: Third Most Abstract Figure, Level of Abstraction Visual Preferences Survey Question Answers for *Signifi*; 2016.

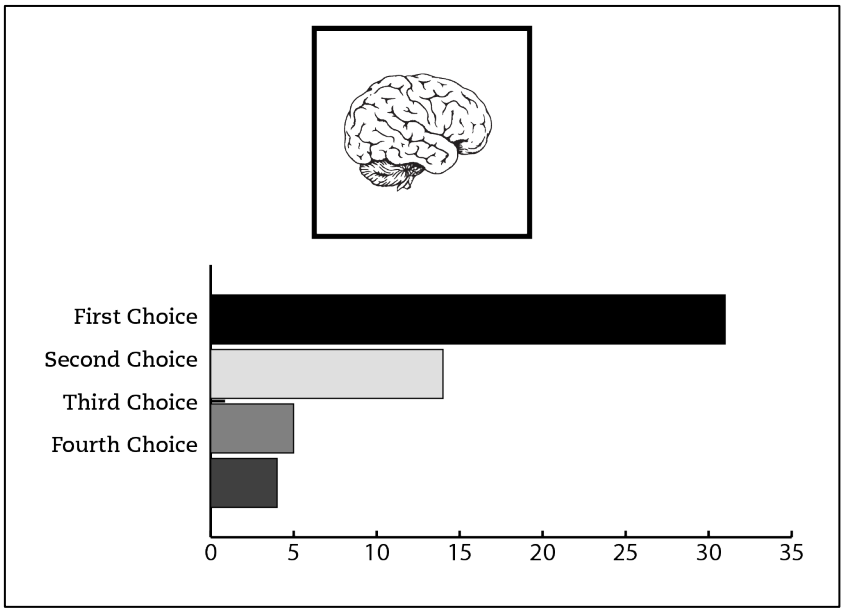


Fig. E.6: Fourth Most Abstract Figure, Level of Abstraction Visual Preferences Survey Question Answers for *Signifi*; 2016.

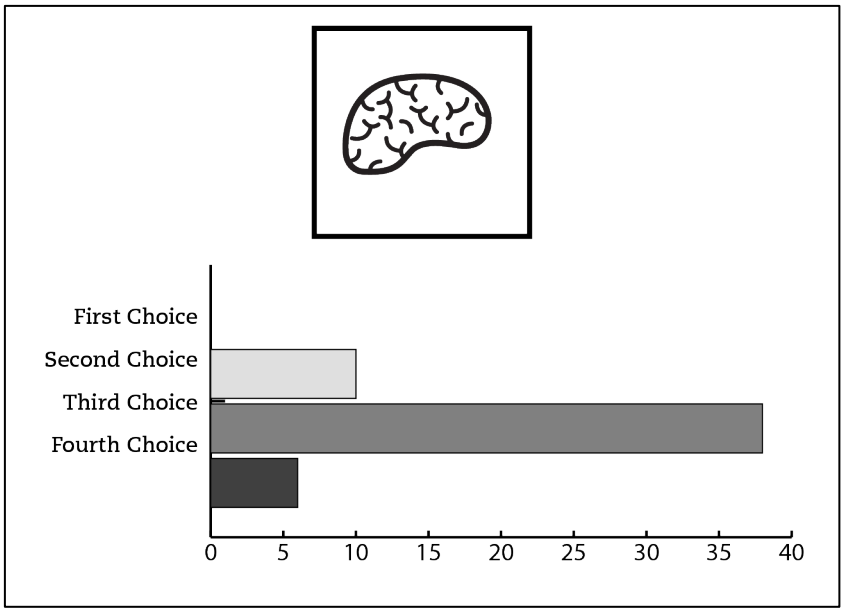


Fig. E.7: Second Most Abstract Figure, Level of Abstraction Visual Preferences Survey Question Answers for *Signifi*; 2016.

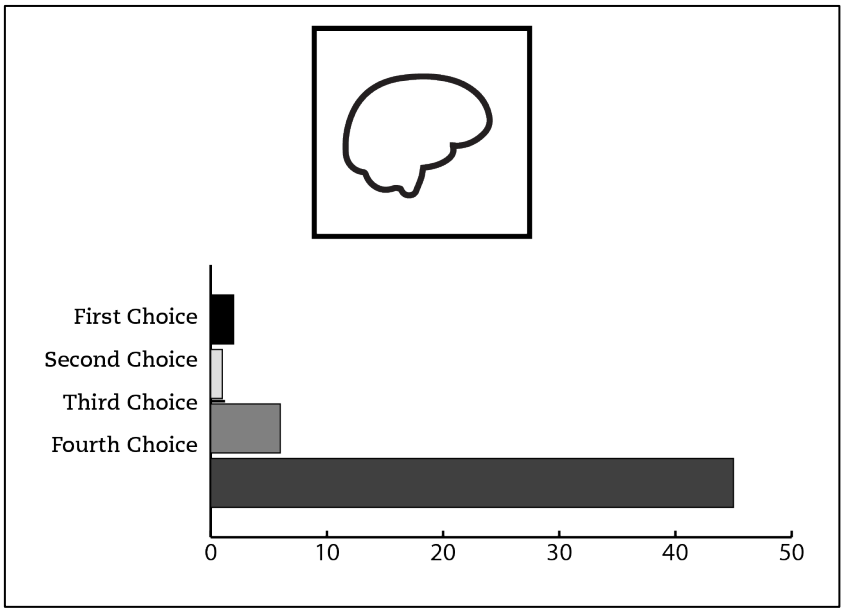


Fig. E.8: Most Abstract Figure, Level of Abstraction Visual Preferences Survey Question Answers for *Signifi*; 2016.

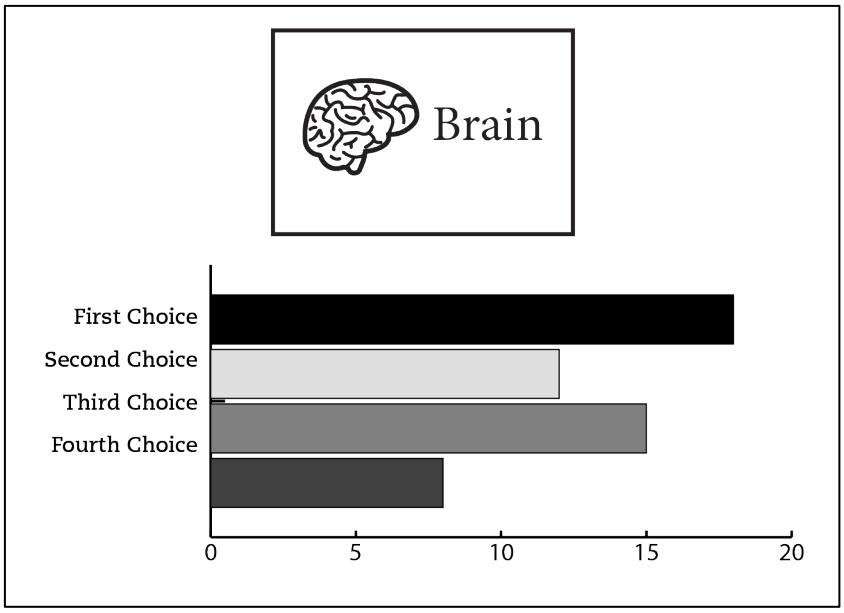


Fig. E.9: Horizontal Alignment with Image Left of Text, Image and Text Orientation Visual Preferences Survey Question Answers for *Signifi*; 2016.

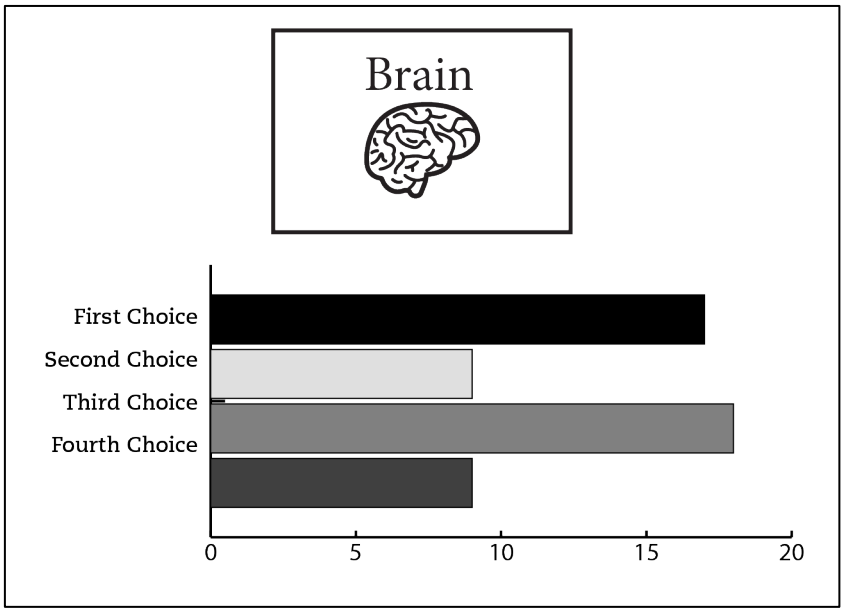


Fig. E.10: Vertical Alignment with Image Below Text, Image and Text Orientation Visual Preferences Survey Question Answers for *Signifi*; 2016.

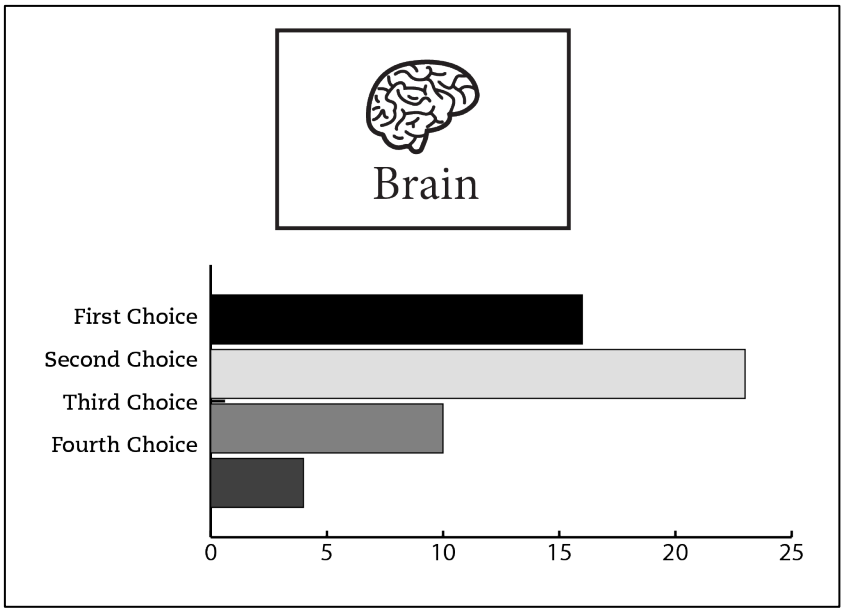


Fig. E.11: Vertical Alignment with Image Below Text, Image and Text Orientation Visual Preferences Survey Question Answers for *Signifi*; 2016.

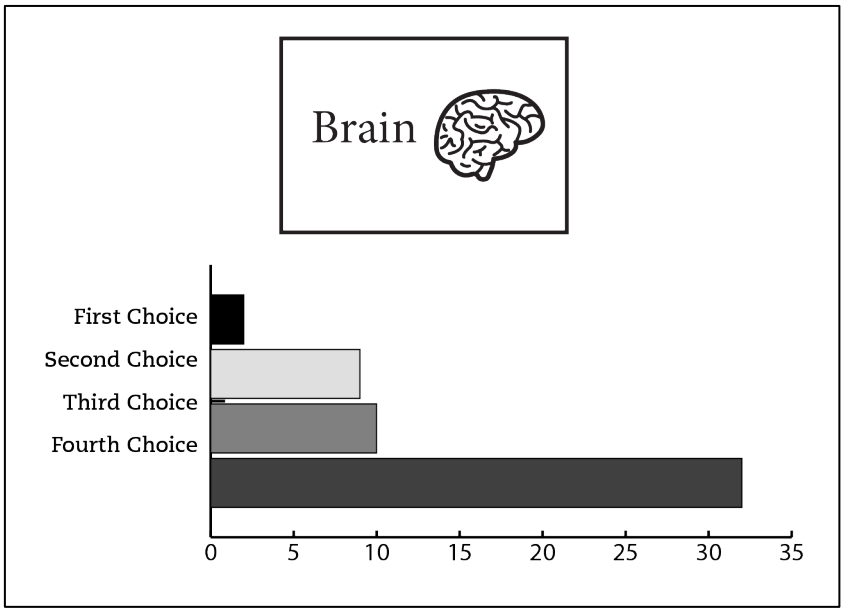


Fig. E.12: Horizontal Alignment with Image Right of Text, Image and Text Orientation Visual Preferences Survey Question Answers for *Signifi*; 2016

APPENDIX F: PARTICIPATION RESULTS

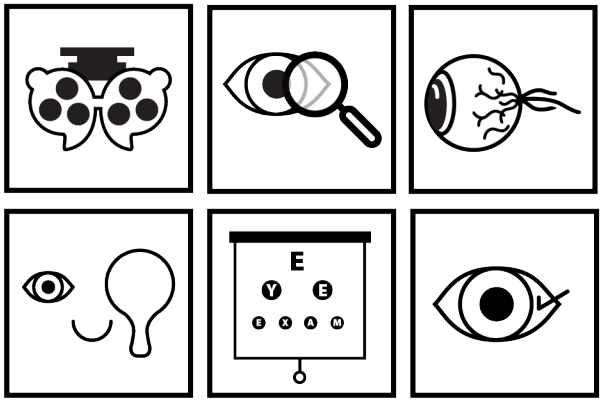


Fig. F.1: Eye Exam, Participation Survey Question Answers for *Signifi*; 2016.

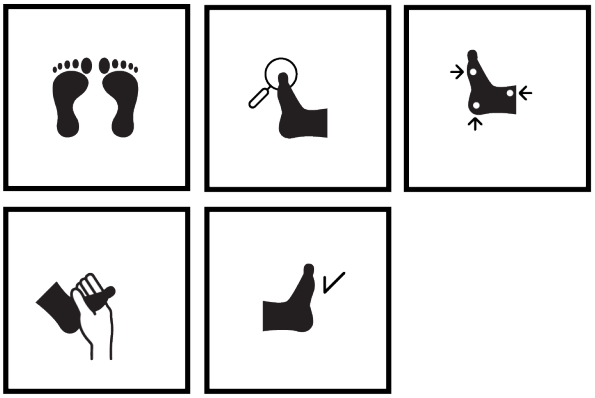


Fig. F.2: Foot Exam, Participation Survey Question Answers for *Signifi*; 2016.

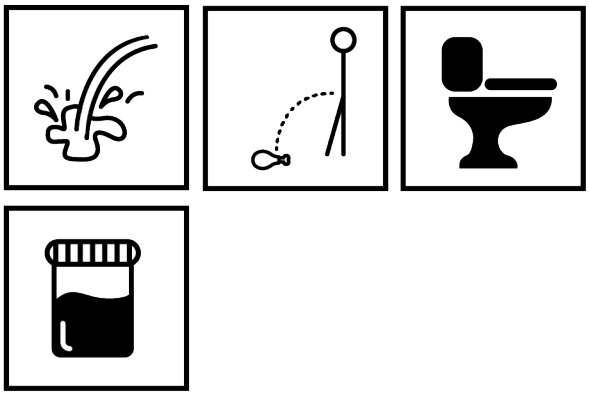


Fig. F.3: Urine Protein, Participation Survey Question Answers for *Signifi*; 2016.

.

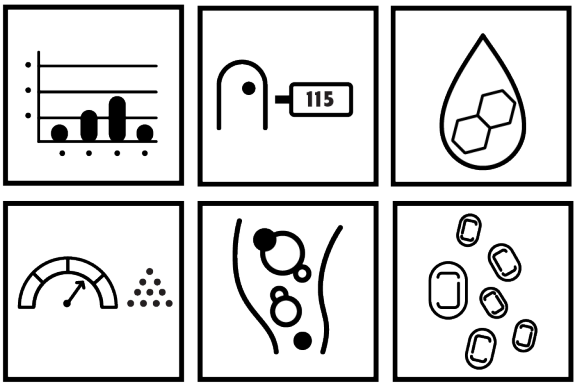


Fig. F.4: HbA1c or *Blood Sugar*, Participation Survey Question Answers for *Signifi*; 2016.

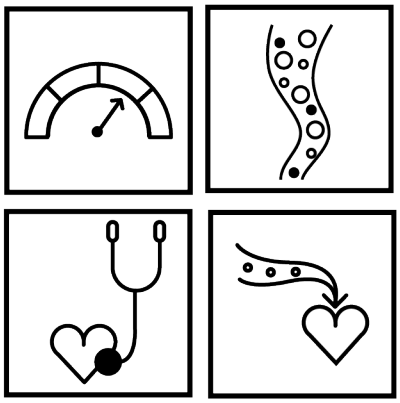


Fig. F.5: Lipid Management or *Cholesterol*, Participation Survey Question Answers for *Signifi*; 2016.

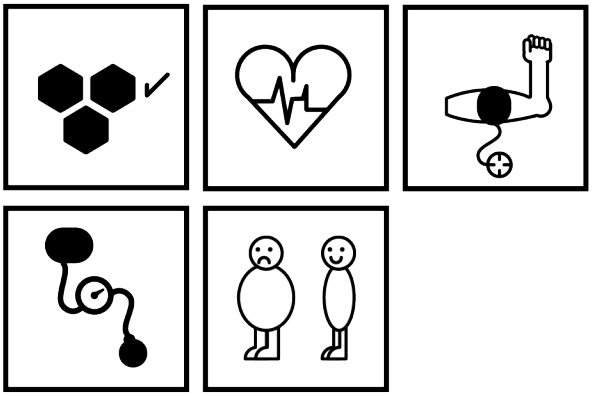


Fig. F.6: Blood Pressure, Participation Survey Question Answers for *Signifi*; 2016.

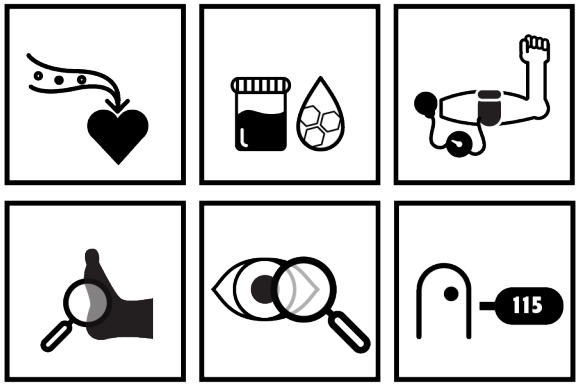


Fig. F.7: Majority of Representations, Participation Survey Question Answers for *Signifi*; 2016

APPENDIX G: FINAL OUTCOMES

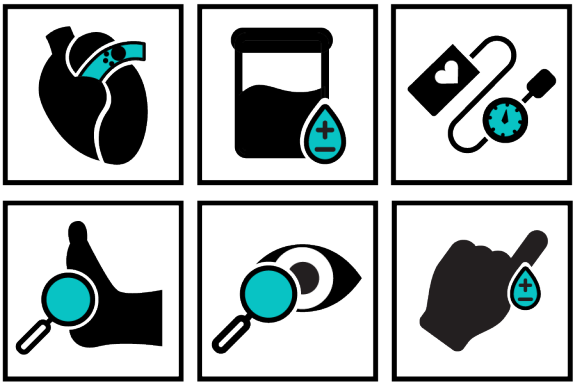


Fig. G.1 Final Pictograms for Diabetes Type II Quality Measures, for *Signifi*; 2016.

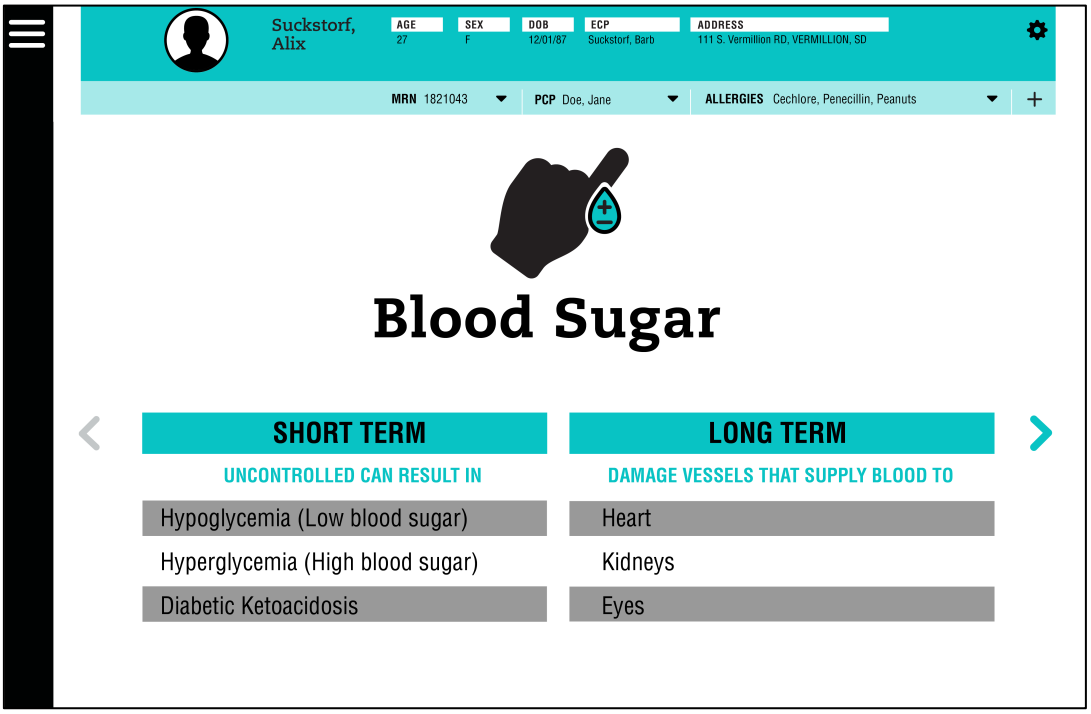


Fig. G.2 Pictogram Based Patient e-Learning Tool Mockup, for *Signifi*; 2016.

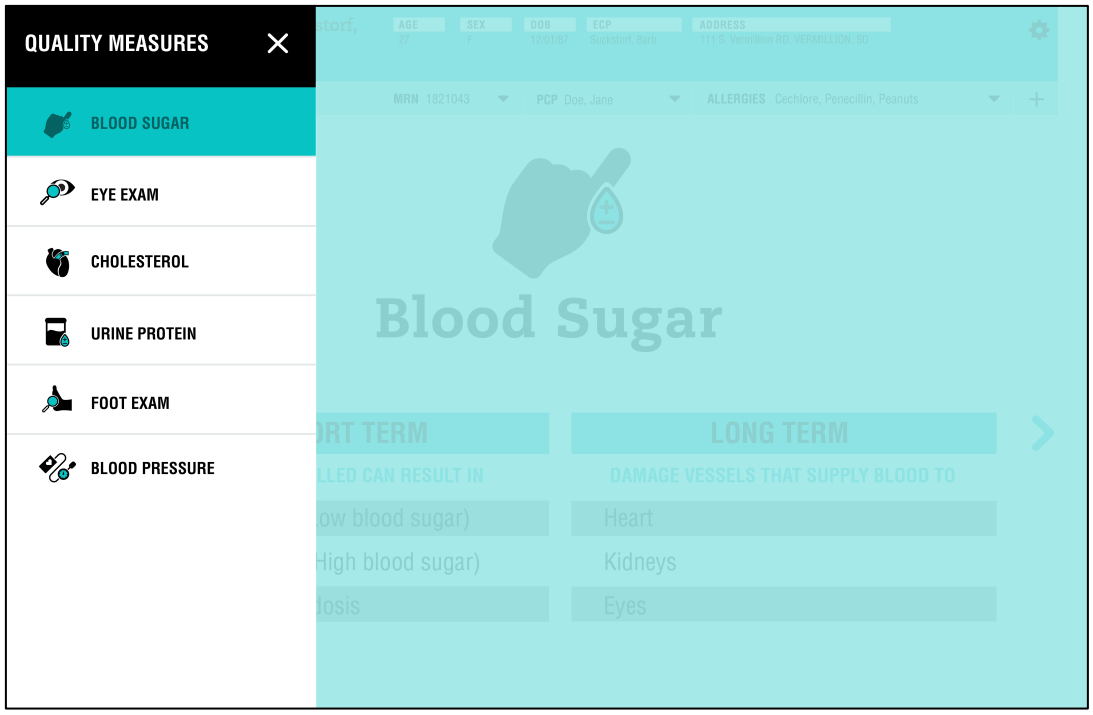


Fig. G.3 Pictogram Based Patient e-Learning Tool Menu, for *Signifi*; 2016.

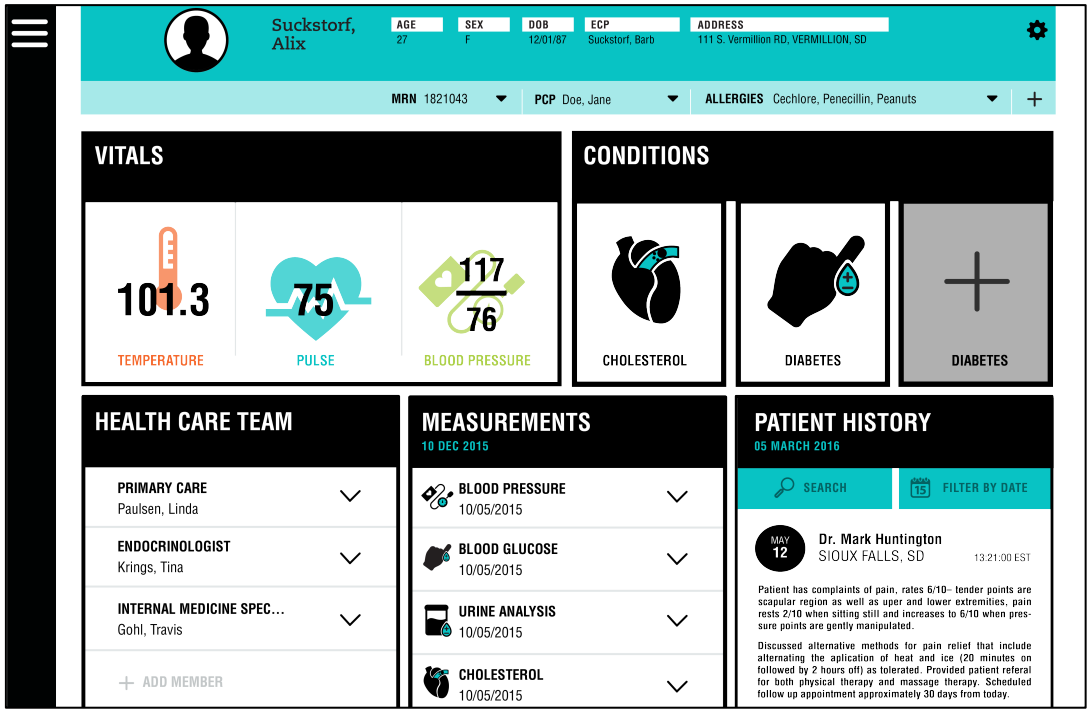


Fig. G.4 Pictogram Based Electronic Health Record Mockup, for *Signifi*; 2016.

Fig. G.5 Mockup: Person Holding Tablet, for *Signifi*; 2016.

Fig. G.6 Mockup: Physician and Patient Screen Sharing, for *Signifi*; 2016.

Fig. G.7 Mockup: Examination Room Large Patient Screen, for *Signifi*; 2016.

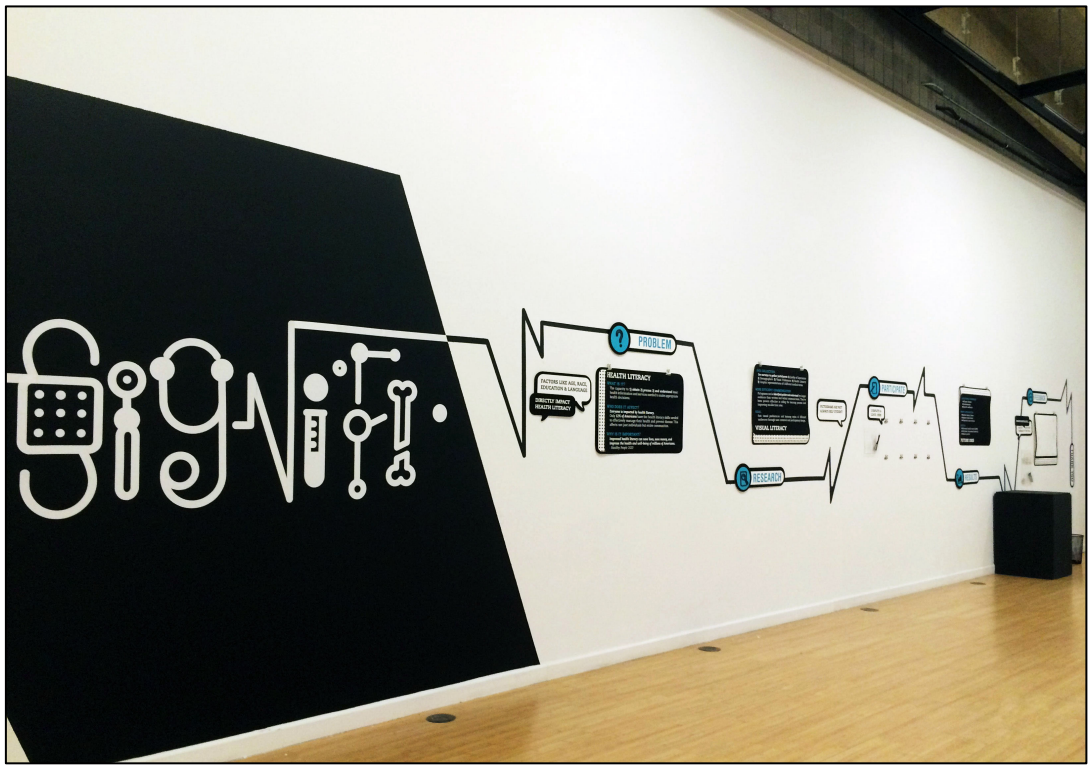


Fig. G.8 *Signifi* Installation; Setup View; 2016.

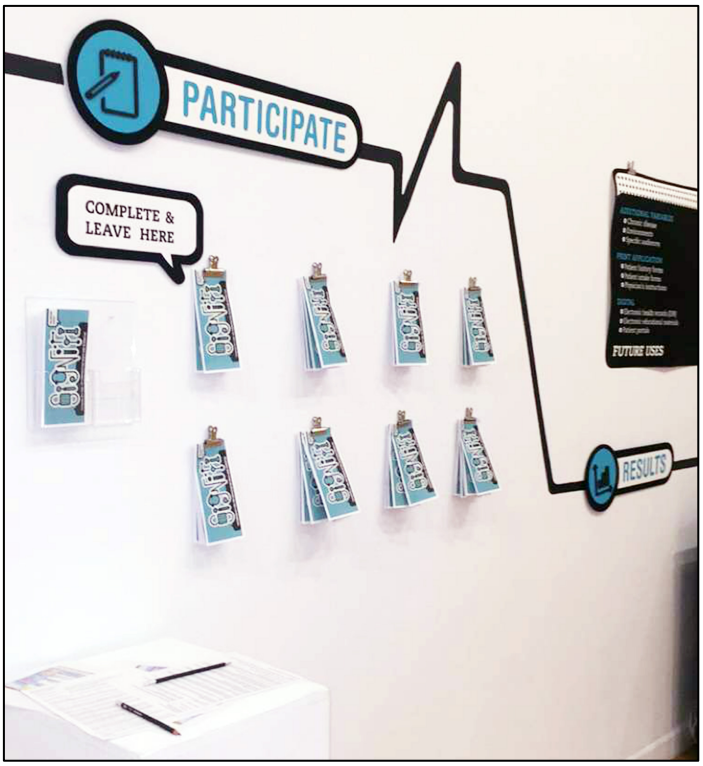


Fig. G.9 *Signifi* Installation; Participation Survey Station 2016.

Fig. G.10 *Signifi* Installation; Pictogram Drawing Station 2016.

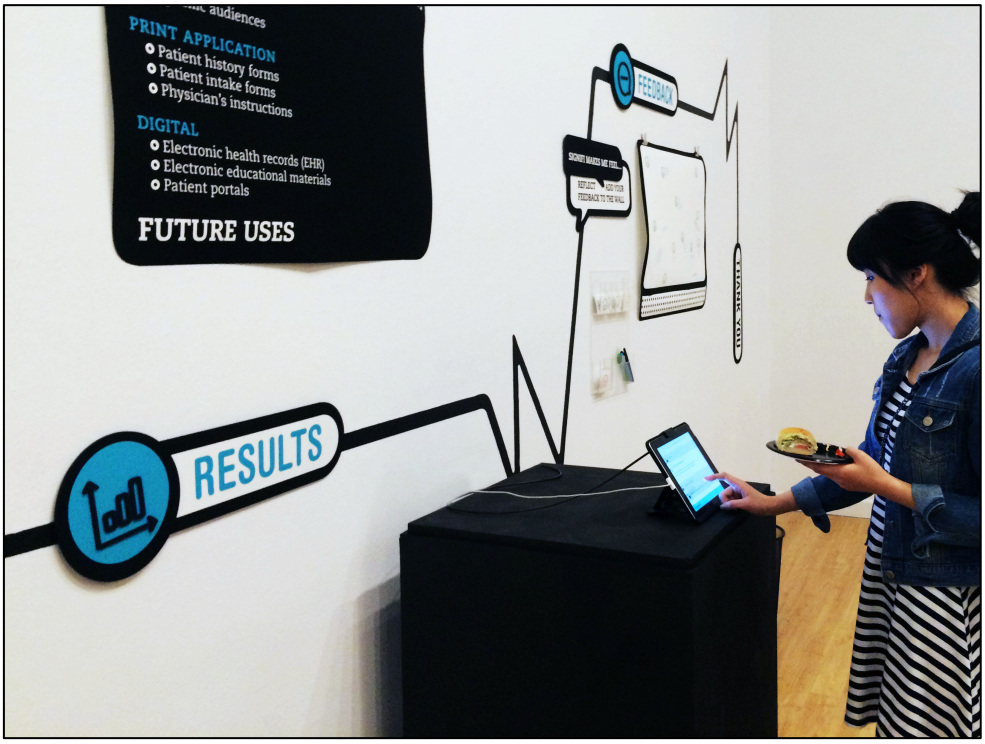


Fig. G.11 *Signifi* Installation; Implementation Interaction Station 2016.

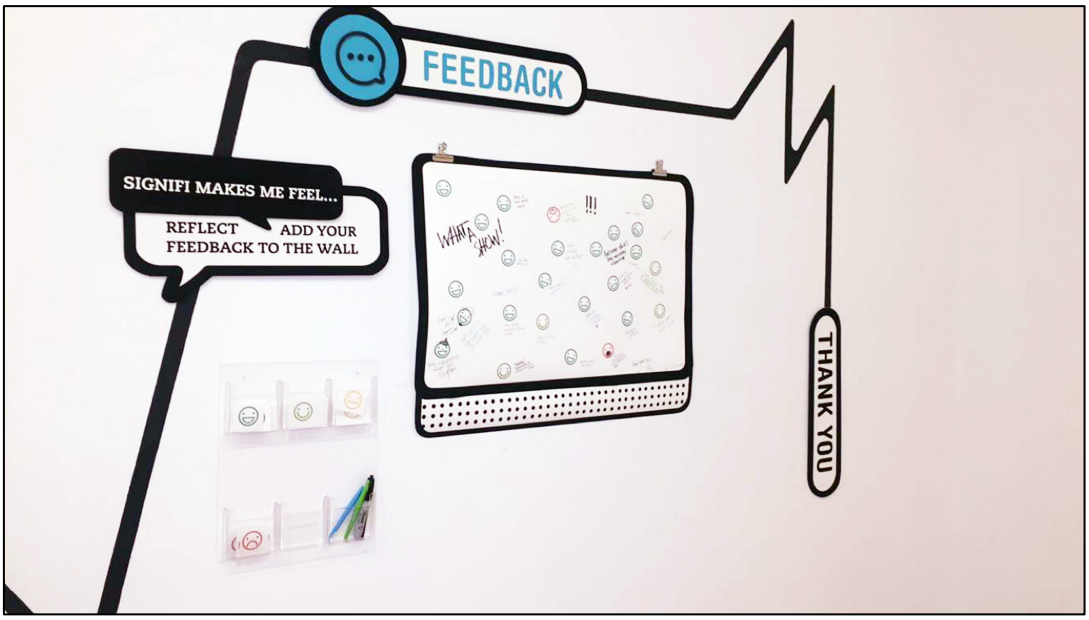


Fig. G.12 *Signifi* Installation; Sticker Emotional Feedback Station 2016.