Is There a Color to Context?: Exploring Domain Associations in Wearable Technology

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Abstract

Studies have found significant impact of domain, or context-of-use, on the social acceptance of wearable technology (Bodine & Gemperle, 2003; Herath et al., 2011; Van Heek, Schaar, Trevisan, Bosowski, & Ziefle, 2014). Therefore, factors which influence domain perceptions are relevant to wearables research. Correspondingly, anecdotal evidence has pointed to the influence of color (e.g. color associations) on wearable technology domain perceptions (Häkkilä, Vahabpour, Colley, Väyrynen, & Koskela, 2015; Starner, Rhodes, Weaver, & Pentland, 1999), yet thorough investigation and empirical evidence of these findings is lacking in the literature. For these reasons, the purpose of this study was to investigate the influence of color and body-worn form on wearable technology domain and function observations.

This study used a mixed methods approach to assess the perceived domains of different colored wearable technology products by third party (limited information) observers. Six different products (three arm-worn and three face/head worn) were pilot tested, ultimately leading to the presentation of an armband, eyewear, and headband product in ten different colors. One of each product was randomly selected and presented to 1,413 (131 to 151 per product) non-colorblind Millennial age Mechanical Turk Workers, 522 of which also answered additional, open-ended questions to probe their selection answers. Participants were asked to assess the different colored stimuli and select the domain(s) in which, in their opinion, the product most likely belonged. T-tests were used to compare the counts of domain selections. Open-ended questions asked participants to first name what they believed the device to be and do, then describe if and why the product was recognized, and finally, to comment on the recognizability of the term wearable technology and its relationship to the presented stimuli.

The clearest and most dominant results were found in the observed influence of product form and body location on perceived domain: Within each product (across colors), there were consistently observed product domain selections, and in open-ended responses there were consistently referenced products and guessed functions. Consistent domain selections regardless of color were seen in both highly recognized products (e.g. armband) and unrecognized products (e.g. headband). Conjointly, there were similar domain selections between comparable product types (e.g. Gaming & Entertainment in smart glasses and in an HMD) and between comparable body locations (e.g. Health & Wellness in arm-worn products). Other information offered by participants in the product discernment process were possible users and use-case scenarios. This study did not find strong, conclusive results that color significantly altered domain perceptions of unidentified products. Certain trends indicated that color had some influence in domain selection. For example, Medical ratings were consistently high when the product color was beige—however, results and count were not often significant. While color may have been a feature utilized in perception, its influence was not dominant; results primarily point to dominant product and body location function associations, in the minds of American Millennials, and highlight the salient interrelationship of both in product discernment. The results and supporting open-ended responses also speak to what is perceived as common—and potentially acceptable. Finally, the results of this study point to the need for more research on color associations and color influence in wearable technology perception. Study limitations are discussed in depth, and suggestions for future research are described.

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Chapter I

"I have come to realize that hostile reactions have less to do with who I am and much more to do with how I am perceived."

-Mann & Niedzviecki (2001), commenting on public reactions to the wearable computer.

Introduction

While wearable technology unit shipments are reported as continuously increasing, (IDC, 2019a), public acceptance has been unpredictable and only a limited number of products have been popular in the market. Wearable technology, by its very name, constitutes a subcategory of dress, but that does not mean that people perceive it or interact with it in the same manner as traditional items of clothing. Similarly, these products are not perceived in the same manner as traditional (non-wearable) consumer technologies. Wearable technologies are subject to "the usability and utility influence of technological systems, the social influence on behavior, and the emotional identity influence of fashion" (Dunne, Profita, & Zeagler, 2014, p.31). In recent years, the importance of social and aesthetic aspects of these hybrid products has been greater realized, and more studies have begun focusing on the perception of wearable technologies and the factors central to social acceptance. Product appearance, features, and context of use, among other aspects, have been shown to influence opinions on design and social acceptability (Bodine & Gemperle, 2003; Fortmann, Heuten, & Boll, 2015; Koo et al., 2016; Pateman, 2015).

Further, wearable technology owners/wearers, the products themselves and their features, and the social beings/observers that make up the social-public, are all important agents in communicating and defining meanings and social norms surrounding wearable technology (Blumer, 1969; Flammer, 2016; Goffman, 1959). Some wearable technology wearers, for instance, have experienced adverse reactions in public settings when wearing certain products. For example, when Google released Google Glass in 2013, there were reports of assault on Glass wearers (who were seen as "Glassholes") for wearing a device perceived as costly and used for recording in public settings (Gross, 2014). Thus, understanding the many ways in which wearable technology may be perceived is an imperative step in determining how the products, and their wearers, will fare in social settings (e.g. what opinions might be made; how others might react; and what such perceptions and reactions might produce in relation, such as modes of social decorum).

Some scholars have reported that color—which in and of itself is an understudied variable in wearables literature—appeared to influence the perceived domain of various products (Häkkilä et al., 2015; Kelly & Gilbert, 2018; Starner et al., 1999), but the information was often anecdotal in nature and lacking empirical evidence. Conversely, prior work has assessed the most common wearable technology products, product locations, functions, and associated domains (Al-Eidan, Al-Khalifa, & Al-Salman, 2018; Berglund, Duvall, & Dunne, 2016; Dehghani & Dangelico, 2017; Silina & Haddadi 2015; Zeagler, 2017) and there is ample evidence that the domain, or context-of-use, of wearable technology significantly affects the social perceptions of a variety of different products—as perceived by the users/wearers (Bodine & Gemperle, 2003; Herath et al., 2011; Van Heek et al., 2014) *and* by the observers (Profita, Albaghli, Findlater, Jaeger, & Kane, 2016). On that note, and despite their mutual role in social settings, the opinions or perceptions of observers or non-users of wearables are also understudied; most reports come from first person user perspectives (Flammer, 2016).

Therefore, this study seeks to examine the assumptions observers make about different body worn technologies and focuses on the potential relationship between color, body-worn form, and perceived product domain. Specifically, this study seeks to determine whether color or body-worn form are closely associated with the perceived product domain of a number of undescribed wearables. As such, the aim of this study is to provide empirical support for the color-findings reported by past scholars. Similarly, such findings may act as a precursor to investigating the influence of visual properties on the social acceptance of wearable technology.

Chapter II

Literature Review

In order to understand how wearable technologies are perceived, the field and products must first be situated. The field's background and trends are first presented to understand where the products are currently situated in the social space. Topics on common and evaluated form factors, placement, and functions are then discussed, as are the various influences on social perceptions and acceptance.

Wearable Technology: History and Trends

In a piece for *Wareable*, a wearable device news site, fashion-technology consultant Amanda Cosco (2016) describes the late 2000s as the period that "catapulted wearable technology into mainstream consciousness" due to the influx of wrist worn activity trackers and subsequent Quantified Self[1] movement. Such devices (wrist worn gadgets and activity trackers in general) maintain the biggest share of the wearables market (Berglund et al., 2016; Gartner, 2018; Richter, 2018). However, and unknown to most, electrically enhanced garments are as old as electricity itself: innovators and developers have been experimenting with and promoting such technology since the 19th century (Barral, 1891; de la Pena, 2001; Gere & Rudoe, 2010; Ryan, 2014). However, most successful developments were carried out by the military (in the 20th century), while consumer development became more prevalent following the creation and advancements of computer technologies following the 1960s (Guler, Gannon, & Sicchio, 2016; Ryan, 2014).

Ariyatum, Holland, Harrison, and Kazi (2005) reviewed early smart clothing and wearable computing production and name three distinct periods of the field's production trajectory leading up to commercialization: a computing and technology focus from the 1980s to 1997 (Period 1), a move towards more garment/fashion and textile integration and wearability in 1998 to 2000 (Period 2), and a drastic increase in commercially available smart clothing in 2001 to 2004 (Period 3). However, imaginative developments and market intrigue stagnated as many early wearables lacked true utility, appealing or comfortable

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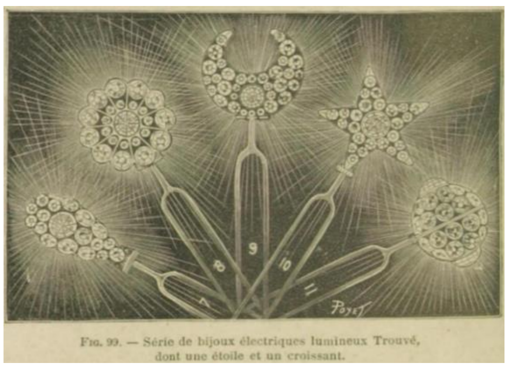
[1] Quantified Self: using data and measurements about the self/body for reflection and behavior management ("Quantified Self," 2012)

design, reliable/accurate components, or feasible manufacturability (see Dunne, 2010). Further, textile-electronic integration was and still is a difficult challenge to overcome, while smaller, rigid products present fewer challenges (Dunne, 2010; Molla, 2017). In conjunction with these issues was the rise in popularity, and therefore shifting focus to the smartphone and similar, often complementary capabilities (Amft & Lukowicz, 2009; Ryan, 2014). Focus turned to functions related to computing, communication, and sensing/sensors—the latter being particularly useful for health and sports utility (Amft & Lukowicz, 2009). More recent studies show that production trends transitioned away from clothing and towards gadgets and accessories.



Figures 1.- 2. Nineteenth century electric jewelry (Barral, 1891)

Figure 3.- 4. (Left) MIT's wearable computers in the 1990s and (Right) MIThril Vest in 2003 ("Wearable Computing at the MIT Media Lab," n.d.)

Recent Trends in Wearable Technology

Studies examining the last two decades of wearable technology—when the field experienced the most growth—can tell us not only what devices have been invented or presented, but what form factors, functions, and related aspects might be more salient in the mind of the everyday person, which may affect product related associations.

Dehghani and Dangelico (2017) explored the Thomson Innovation database and recorded 1,062 registered smart wearable technology patents between 1998 and 2015. They found a noticeable increase starting from 2006 to 2013 (28 to 94 patents) and observed a marked spike therein after: between 2013 and 2015, 575 patents were registered. Smartwatches accounted for over 50% of the patents and smart glasses accounted for approximately 18%. The researchers also noted that smart clothing patents were registered relatively early in the analyzed time period, but further development in the later years was not heavily observed, which is in line with the trajectory discussed earlier.

Similarly, Parola Analytics Inc. (2018) examined over three thousand wearable technology medically-related patents and applications from 2008 to 2017 and noted an increase in filings and applications between 2012 to 2014. The numbers, they report, peaked in 2014. Their findings showed that device functions concentrated on monitoring-type devices; the intended users centered around remote users; and the device locations were primarily on the wrist.

Silina and Haddadi (2015) examined more in-depth trends, in jewelry-like wearable devices, marketed prior to February 2015. Instead of patent research, they examined actual products accessible through Google web searches. An exhaustive list of 187 devices (145 of which were developed after 2012), with details on makers, materials, and functions were recorded by the researchers and analyzed with descriptive statistics. Silina and Haddadi found that almost 75% of these devices were commercial products, others being academic research or art projects. They further found that 57% of the devices could be described as jewelry in form and material, while 40% were better classified as gadgets. Gadgets, for instance, were fabricated with materials such as silicone, hard plastics, and screen displays, while jewelry items made use of traditional materials like wood or precious stones.

The researchers also examined the relative market areas of each device. A majority (57%) of the devices examined by Silina and Haddadi fell under the Glamour & Fashion domain—but the researchers reported that multiple combined domains were often present in a single device. Other recorded domains included Business, Safety, Health, Wellness, Sport, Lifestyle, and Communication. Prior to 2013, Silina and Haddadi found that market sectors were dominated by Sports and Wellness, but by 2015, there was a shift to Glamour & Fashion and Communication. The most prevalent body locations, deduced by device popularity, were wrists and arms (e.g. bracelets, bands, armlets). However, the focus of their study was only on jewelry-like products.

Following this study, Berglund et al. (2016) examined trends in all wearable technologies discoverable through web searches, providing an exhaustive list of 793 observed devices up to 2014, and a snapshot of 103 devices released or prototyped between 2014 to 2015. Products and their details were recorded and analyzed with descriptive statistics. Phenomenologically derived domains included Healthcare & Wellness, Sports & Fitness, Lifestyle & Fashion, Security & Prevention, and Gaming, Interface, & Novelty. The researchers found that prior to 2014, trending domains were observed at a similar rate (23.7 to 28.6%) between Lifestyle & Fashion, Gaming & Novelty, and Sports & Fitness, with Healthcare & Wellness following at 16%. However, a shift occurred in the 2014 to 2015 snapshot, with Lifestyle & Fashion (37.9%) and Sports & Fitness (40.8%) eclipsing all others (<8%) in popularity.

Device frequency and body location comparisons between the two time periods were presented by the authors. As displayed in their provided body maps, and mirroring previously mentioned research, there was a marked shift towards wrist worn accessories, which Berglund et al. equate to the "rapid decrease in size and power consumption of enabling hardware" in technological development (p. 40), as well as to ease of manufacturing, and to consumer behavior trends related to accessibility and adoption (i.e. exposure positively influencing acceptance). They note that the most popular functions in the pre-2014 list were heating, gaming, music, and fitness monitoring products, while the most popular items in the 2014 to 2015 record were largely jewelry and fitness monitors.

Al-Eidan, Al-Khalifa, and Al-Salman (2018) reviewed recent (2014 to 2018) wearable technology focused academic literature and found that the most commonly studied products were smartwatches, smart glasses/HMDs/eyewear, light-up products, textiles, gloves, nail and hair products, and products with 'magnetic inputs'. However, the focus of their review was on wrist-worn devices. In their search, they found that the most prominent domains under which the products were being studied were that of the activity and health sectors.

Some explanation for the domain-body location pairings mentioned above can be explained by feasibility of the function objective. In a review of literature, Zeagler (2017) found specific themes in wearable technology functions relative to body locations. Although arms and hands were found to be more socially acceptable body locations, many locations were determined by a product's purpose, technological capability, or body proxemics (Zeagler, 2017). Biological sensing/monitoring was the most covered function in Zeagler's review, and relative body locations included the upper arms, wrists, fingers, chest, ears, nose, forehead, upper thighs, and ankles—depending on the measurement needed (e.g. respiration, blood pressure, etc.). However, the most common locations for biosensing across activity were the wrists, upper arm, and ears. Other functions covered were motion sensing and network interaction (i.e. communication). Products that were developed for motion and movement sensing could be placed all over the body, though specific locations again related to what was being monitored (e.g. joints, or limbs, etc.). In regards to inter-product communication feasibility, the hands, arms, neck, ears, and head were the leading device placement locations for the best networking capabilities.

On that note, industry firm findings echo and similarly predict both the type and infiltration of products and product functions, reported above, in the consumer marketplace. ABI Research (2014) released a study in 2014 on the unit shipments of wearable cameras, sports/activity trackers, 3D motions trackers, clothing, smartwatches, healthcare devices, and smart glasses, and reported that sports/activity trackers dominated unit shipments in 2013 (60.3%) and 2014 (47.4%), followed by healthcare at 24.9% and 25.1%, and wearable cameras at 12.3% and 12.15%, in 2013 and 2014 respectively. All others measured at less than 9%. However, their forecasts for 2015 predicted an increase in smart watches (to more than 17%, from <3% in 2013) and smart glasses (to more than 7%, from <1% in 2013). In fact, Gartner, (2018) surveyed worldwide shipments of smartwatches, wristbands, sports watches, smart clothing, head-mounted displays, and earwear (not included in the previous survey) in the year 2017 and found the following proportions: watches and wristbands equaled 68.3% of shipments, ear devices equaled

21.5%, head-mounted displays were at 19.1%. Smart clothing measured only 2.9%.

IDC measured wearable unit shipments worldwide from 2014 to 2017 and found that wristwear, compared to eyewear, clothing, and other miscellaneous items, dominated the market by more than 90% each year (IDC, 2017). Wearable unit shipments and associated vendors from 2014 to 2018 experienced a growth from approximately 29 million units shipped in 2014 to 172 million in 2018 and dominating vendors included Apple, Xiamoi, Fitbit, Garmin, Fossil, Samsung, and Huawei (IDC, 2019a; IDC, 2019b). FitBit was considered the market leader until 2017, when Apple Watch sales overtook the fitness brand (Richter, 2018). Previously it had been reported that FitBit was number one in advertisement spending compared to other wearables brands (Aditi, 2015). Other notable and influential brands from the past decade include Pebble smartwatches, Google Glass (smart glasses) and Cardboard (virtual reality head mount), and Snapchat Spectacles, with Google Glass being the most notorious (Gibbs, 2017). Glass production was halted after two years due to public anger and opposition to the expensive, face worn recording device (Gibbs, 2017; Gross, 2014).

Important to note, regardless of market reporting on shipments and sales, is the extent to which the public is familiar with wearables. In 2016, PwC (2019) surveyed 18 to 64 year-old Americans on the types of wearable tech devices they owned, and found that 45% owned fitness bands, 27% owned smart watches, 15% owned smart glasses, 14% owned a video/photo taking device, and 12% owned enhanced clothing. Similarly, in 2017 Statista asked more than one thousand US individuals aged 18 to 69 (52% female) if they had heard of wearable computing devices, and 69% answered that they had heard of said products (Statista, 2017). In the same study, they asked what devices the participants owned and 30% said fitness bands, 22% said smartwatches, 14% named smart glasses or VR headsets, 5% said clothing and 54% marked none. When asked which products were of most interest, 37% named sensor-based wristwear, 36% said head or eyewear, 33% named medical devices, 18% said smart clothing, 1% named an unspecified option, and 28% marked no interest. The overarching topic of the survey focused on augmented and virtual reality; 33% had previous experience with virtual reality headsets.

Perception of Wearable Technology

Wearable technology, as a form of production and as a consumer recognized market has grown drastically in the last two decades. However, where the field stands is contested. Industry reports repeatedly forecast exponential growth, but brand and product failures are common occurrences. In a review of the "Social Aspects of Wearability and Interaction," Dunne, Profita, and Zeagler (2014) note that much of wearable technology development and research has focused more on the function of the technology rather than the social and aesthetic rules of dress, for instance, sometimes requiring use or interactions (e.g. gestures) that drew undesired attention (e.g. by being out of context). However, items of dress—including wearable technologies—are aesthetic tools for expressing individual and group identity and are governed by social decorum (Dunne, Profita, & Zeagler, 2014). Hence, both the technological and social aspects affect the acceptance of wearables. In more recent years the importance of each has been greater realized and thus, there has been more research on both. For example, physical wearability and comfort (Gemperle, Kasabach, Stivoric, Bauer, & Martin, 1998, Knight et al., 2006), device technology (e.g. battery life, display, etc.) (Puri et al., 2017), body location of interaction or placement of products (Park et al., 2012; Dunne, Profita, & Zeagler, 2014; Zeagler, 2017), and product context of use (Bodine & Gemperle, 2003; Pateman, 2015), have all been reported as important to the perception or acceptance of wearable technologies.

Numerous studies (Choi & Kim, 2016; Chuah et al., 2016; Hwang, 2014; Kim & Shin, 2015; Mercer et al., 2016; Nasir & Yurder, 2015; Puri et al., 2017; Spagnolli, Guardigli, Orso, Varotto, & Gamberini, 2015) have explored consumer acceptance of wearable technology using the Technology Acceptance Model (TAM) (Davis, Bagozzi, & Warshaw, 1989) which looks at factors like perceived usefulness, perceived ease of use, attitude towards use, etc., to predict actual adoption of the device. In addition to the standard components of the TAM, Chuah et al (2016), Choi and Kim (2016), Hwang (2014), and Puri et al., 2017 also questioned the fashion, luxury, or aesthetic factors in wearables and how they fit into the TAM. Hwang (2014) found that aesthetics did not impact intention to use the products under study (i.e. solar powered clothing), while Puri et al. (2017) reported that participants were concerned with aesthetics in activity trackers, and Chuah et al. (2016) and Choi and Kim (2016) found an effect of such variables on smartwatch perception (e.g. perceived visibility, enjoyment, etc.). Interestingly, Chua et al. (2016) also found that the smart watches under study were not perceived by the majority as a fashion product.

Similarly, in a study on wearable electronic nose-worn devices for diabetes patients, participants had shape and color preferences that factored into their product evaluations (Koo et al, 2016). And, in an assessment of smart wearable healthcare devices, which also focused on body location preferences, participants expressed concerns about whether the devices would look similar to or different from normal garments (Park et al., 2012). Similar findings can be found in other studies: in a study on technological jewelry, form factor was ranked as more important than body location placement (Fortmann, Heuten, and Boll, 2015); in a study on smartwatches, hedonic and pragmatic quality were influenced to varying degrees by device screen size and shape (Kim, 2017); and, in evaluations of activity trackers, the device reliability and device accuracy, as well as comfort, visibility, appearance, and context of use affected product evaluation (Pateman, 2015).

These findings are important. Understanding how technologies, particularly worn technologies, are perceived can aid in understanding how the people wearing the objects will be perceived. Dress is an aesthetic tool for expressing identity, and worn objects have more influence over a person's identity than carried objects (Dunne, Profita, & Zeagler, 2014). Further, worn items are not only a tool for expression, but a means of communication. A dressed body is an assemblage of information about both the objects and the wearer, together (DeLong, 1998). DeLong (1998) names this concept the apparel-body-construct, stating that the person, their body, and their dress (and its features) are constituent components of an organized whole—a visual structure of information. And, visual information (i.e. images), she states, ignite swifter reactions than messages conveyed through writing. Delong describes that visual features are directly (e.g. a ring on the fourth finger of a person's left hand) and indirectly (e.g. a ring in this location indicates that the person is married) perceptible to others, each with their own separate meanings, but that inferences about relationships between all features come together to inform overall perception. DeLong suggests studying the individual components, "their makeup and interaction," "the relationships and associations," to better understand the "visual relationships [that] become priorities" and to understand the dressed body in whole (p.57-59).

Just as DeLong (1998) details in the appraisal of the apparel-body-construct, Pinson (1986) similarly describes general (unworn) objects, specifically when there is limited information and past experience with the object. Pinson (1986) states that in cases where limited information is available or known, one may make inferences based on the information that is available (the appearance, for example) in the formation of a belief about the product. This evaluation, based on missing information, facilitates opinions or judgements about a product based on an often unconscious and sometimes nonlinear search for "product attribute inter-relationships" that are known to the observer (Pinson, 1986, p.21). Pinson states that these inter-relationships are believed attribute associations, between the recognized and unrecognized features, that are subjective and configural—often based on similar features or products most typical or salient to the viewer. The following attributes (cues) that may be utilized in the implicit evaluation of an unknown product by an individual include product noise, odor, price, brand name, symbols, and the physical characteristics of shape, weight, material, design, and color, etc. (see Pinson, 1986). Color is one particularly impactful product feature; yet, color is understudied and underreported in wearable technology literature and reviews. In none of the previously mentioned studies or product reports could information on the trends or typical colors in wearable technology products be located.

The Impact of Color on Perception

Although some say that shape is the most influential cue in object recognition (Biederman & Bar, 1999; Biederman & Ju, 1988), and other factors, such as product features or the body, are also influential in the object evaluation process, the influence of color in object discernment cannot be ignored. In a review and analysis of 35 color and object recognition studies, researchers reported that color positively influences the process and speed of object categorization when object color and shape are typically highly congruent and to a lesser degree in those that are not highly congruent; color can also help in identification of nontypical or unclear objects in a variety of semantic categories; and color can facilitate the process of connecting object form to object name (see Bramão, Reis, Petersson, & Faísca, 2011). Further, color effects on object recognition were found regardless of whether a study used line drawings or photographs, or if stimuli had or did not have surface details (Bramão, Reis, Petersson, & Faísca, 2011).

Color is pervasive. Color is a large part of how we operate in and experience the world. Color is intrinsically related to light: the different colors we see are made of different wavelengths of light; we are able to see and distinguish objects and their colors based on the wavelengths the objects reflect (Purves et al., 2001). Color provides information about the world in which we live in the physical process of differentiating shapes and surrounding space, but also as a significant means of delivering more abstract information (Dondis, 1973; Lester, 1994). For instance, the color of the leaves on a tree can mark the change of seasons, and the color of a piece of fruit can indicate its edibility. Such meanings may form color associations; associations are actual or perceived relationships between two or more variables, derived from frequent or marked experience or learning (Elliot & Maier, 2012; Klein, 2018), as was described by Pinson (1986) and perceived feature relationships. Further, some associations are derived from biological inclinations and some are derived from social learning (Elliot & Maier, 2012). Associations can also develop from typicality or availability, preference or popularity, or standardizations/regulations, etc. (Blaszczyk, 2012; Kaya & Epps, 2004; Tanaka & Presnell, 1999). For example, the American government created and requires standardized safety-related color meanings (e.g. yellow and warning, red and danger) for businesses to decrease occupational hazards (Blaszcyk, 2012) and hence, safety related color associations in occupational settings have been widely reported by industry workers (Or & Wang, 2014).

Associations are very often contextual and meaning inferred can differ between product categories or use scenarios (Elliot & Maier, 2012). Associations can also have influence over human behavior and emotion (Elliot & Maier, 2012). For instance, red—one of the most highly studied colors in color association literature—has been found to have significant association with, and effect on, perceived dominance or aggression when in athletic uniforms (Krenn, 2015), as well as sexual attraction in connection to female dress (Elliot & Niesta, 2008), and energy consumption (Lu, Ham, & Midden, 2016) or danger (Chan & Ng, 2009) in machines and industry products. Different colors within a single form may also be associated with different meanings, for example with that of a black dress and mourning, or a white dress and weddings (Zoi & Maria, 2014).

That being said, color associations are not universal. Associations, being heavily influenced through social learning and subjective experience, and being context specific, are influenced by place, time, and culture (Elliot & Maier, 2012). For example, color naming and categorization are influenced by language and culture and experience, thus color perceptions differ between cultures (Roberson, Davidoff, Davies, & Shapiro, 2005; Roberson, Davies, & Davidoff, 2000)—though similarities, for some cultures, do exist (Elliot & Maier, 2012; Kay & Cook, 2016). For example, the association between white dresses and weddings are found in multiple western countries, but in many Asian cultures (e.g. in China, Indonesia, and Vietnam), the color white is associated with mourning, and the color red, with weddings (Zoi & Maria, 2014).

Because associations are also temporally situated, they may last or change accordingly. Dominating color schemes in product design (in Western countries), in particular, appear to shift approximately every decade (Valan, 2012). Pastel colors, for instance, are considered characteristic and indicative of the 1950s time period for American products (Valan, 2012). Other changes occur more slowly. For example, early computers (circa 1970s) were beige in color, but consumers demanded different colors as personal computers became more common (Lohr, 2002). By the 1990s and still to this day, metallics, white, gray, and black are the colors most associated with laptops, and cell phones (Lohr, 2002; Simeone, 2012).

Color and Wearable Technology

Color is largely understudied in wearable technology research. An exhaustive search for color was conducted and the term was not often found in research titles or subject terms. The majority of studies discussing specifically the topic of color in wearable devices concerned the construction or use of assistive technologies for the colorblind (Carcedo et al., 2016; Fuller & Sadovnik, 2017; Medeiros, Stearns, Findlater, Chen, & Froehlich, 2017; Popleteev, Louveton, & McCall, 2015; Tanuwidjaja et al., 2014), the technical design of textiles with color changing properties (Berzowska & Skorobogatiy, 2010; Gauvreau et al., 2008; Huang et al., 2016; Invernale, Ding, & Sotzing, 2011; Laforgue, 2010; Peiris, Tharakan, Cheok, & Newton, 2011) or the study of wearable devices with colored lights that communicate information or express or affect emotion (Choi, Kim, Pan, & Jeung, 2007; Li, Zheng, Lu, Ying, & Yao, 2017; Núñez-Pacheco & Loke, 2014; Pradana, Cheok, Inami, Tewell, & Choi, 2014; Sokolova & Fernández-Caballero, 2015; Zhao & Paradiso, 2015).

Color is sometimes listed under the umbrella term "aesthetics" and its general evaluation in wearable technology appraisal, but not measured as its own feature (Hwang, 2014; Reinelt, Hadish, & Ernst, 2016; Yang, Yu, Zo, & Choi, 2016); or more specifically it is often one part of the appraisal of preferred, appropriate or appealing design (Fortmann et al., 2015; Häkkilä et al., 2015; Hsiao & Chen, 2017; Juhlin, Zhang, Sundbom, & Fernaeus, 2013; Juhlin, Zhang, Wang, & Andersson, 2016; Koo et al., 2016; Kuru & Erbuğ, 2013; Reinelt et al., 2016; Thilo, Bilger, Halfens, Schols, & Hahn, 2016). Users in most of these studies mentioned wanting wearables to come in either multiple or customizable color choices to match different outfits (Fortmann et al., 2015; Juhlin, Zhang, Sundbom, & Fernaeus, 2013; Juhlin, Zhang, Wang, & Andersson, 2016; Koo et. al, 2016) or simply rated satisfaction with the color of the presented device (Hsiao & Chen, 2017).

However, in an evaluation of a wearable system for diabetes patients, respondents wanted multiple color options, but also rated preferences; the second highest preference was for natural colors (e.g. beige, black, brown) (Koo et al, 2016). Worn medical products are often made with the intention to match a potential wearer's skin tone (Stipe, 2017), but, historically, this process has not been inclusive (Van Alstyne, 2019). While inclusive skin-tone matching color ranges were created in past decades, they have only recently become more available (Van Alstyne, 2019); historically, beige has been the typical color used in wearable medical devices (Stipe, 2017). Other relevant findings are discussed in the next section.

Color Associations in Wearable Technology. Conversations about color associations were present in some of the studies on wearable technologies with colored lights (listed in the previous section), but the associations that were reviewed focused on physiological or emotion-based associations. In these studies, colors that were chosen were based on the understanding that colors may elicit or represent emotion or valence and arousal (Suk & Irtel, 2010). For example, in Li et al's (2017) work documenting the creation of emotion-expressing hair colors, green lights were used to show calmness, blue to show sadness, and red to show happiness. Similarly, Nunez and Loke (2014) designed a heartbeat-expressing garment and chose blue to represent a slow heartbeat, and engineered the color to become warmer as the portrayed heartrate increased. See Choi et. al's (2007) work for an extensive list of common psychological associations related to different colors and a proffered emotion-expression matrix for using colored lights in clothing.

In some of the design-evaluation studies listed in the previous section, perceived color associations have been documented, but in limited scope. For example, researchers from Middle East Technical University, Kuru & Erbuğ (2013) presented photographs of wearable mobile phones in interviews with 30 individuals (18 males, 20 to 30 years old), using the repertory grid technique to evaluate perceptions of the devices' pragmatic and hedonic qualities. Color was deemed a contributing factor to the aesthetic and technological appeal and novelty of the on-body phones. In these interviews, individuals in this study associated "transparency" of color, pattern, and material with technological appeal and novelty—and said that they "*expect* [emphasis added] technological products to have a certain colour and material" (p.913). However, aside from "transparency," any expected hues were not mentioned in the paper.

Color associations have arisen anecdotally in other studies as well. Häkkilä et al. (2015), researchers from Finland, developed four head-mounted display/smart glasses concepts in varying shapes and colors and presented them in three focus group sessions consisting of 14 participants (8 males, 20 to 23 years old) who all had experience using mobile technology. Participants commented on the design of the device, its social acceptability, and perceived practicality. Color associations were not fixed questions, but references did arise in conversation. In reaction to a green and purple headset, one participant stated that, due to the colors, the device would be for young boys. And with another product, one participant stated that the device design would be appropriate "for working" (a color was not named as the reason) while a second participant described the same device as something that would be used in a hospital setting due to its color—white. White has commonly been used in medical settings and medical clothing since the early 19th century, as it is associated with cleanliness (Hochberg, 2007). The bulkiness of the product as well as it's unappealing design were also given as reasons for this product's expected use—these aspects were perceived as acceptable only in contexts that were seen as more necessary (Häkkilä et al., 2015).

This finding mirrors early experiences of some of the pioneering wearers/designers of wearable computers. Starner, Rhodes, Weaver, and Pentland (1999), members of the MIT Computing Project in the United States, described their personal experiences wearing the Private Eye (a head mounted display) in different colors. They stated that laypeople often assumed the Private Eye was a medical device when it was white or beige, an industry device when it was grey, and a general consumer electronic when it was black. With the Private Eye, bystanders used color to translate perceived product domain, and while their experiences took place in a different country (America) and time (the 1990s) than Häkkilä et al.'s (2015) study, similar findings were recorded for the color white. There are also possible similarities for their beige findings and Koo et al's (2016) report. That being said, Starner et al. (1999) also describe their bystander perceptions as changing with time, but more color information was not provided.

Perceived Function and Social Acceptability

The idea that color may connote device function or context-of-use is especially apposite to the study of social perceptions and acceptance of wearable technology. Kelly and Gilbert (2018) recently studied the impact of device and device function on perceived social acceptability. They presented three products, each in one of two variations, to a university-derived sample in Iowa and a survey registry-derived sample in Silicon Valley. The products included a wrist worn device that was described as either a wearable phone or a smartwatch; an earbud that was described only as a wireless Bluetooth device, but presented in either beige or in black (colors selected were attributed to the proffered association between beige with medical and black with style); and a forehead band that was described as either a fitness tool or a medical tool. The forehead band images were similarly portrayed in different colors: black (fitness) and white (medical); however, for this product, the color difference was not explicitly called out by the researchers. Kelly and Gilbert found a significant difference between the two participant samples (participants from Silicon Valley found the products more acceptable than the Iowans) and a significant difference between the social acceptability of the two different forehead bands (medical bands were rated as more acceptable than the fitness bands). The form factor was not received well for either, but acceptability appeared to relate to need/usefulness and was thus higher for the medical band. The researchers found no difference between the social acceptability of the two wrist worn devices or the two earpieces. However, regarding the earbud, the researchers stated that participant comments relating the device to a hearing aid (medical product) when the product was beige were much more frequent (i.e. by two-thirds) than when the product was black. Whether or not color influenced the other products is indiscernible, given that this aspect was only discussed for the earbuds.

More literature on the relationship between color, function, and social acceptability is lacking; however, other researchers have examined and established the relationship between perceived function and social acceptability. Van Heek et al. (2014) surveyed 172 German individuals on factors important in smart textiles in a medical versus a sports context. Although participants agreed that all factors were important in both contexts, stronger agreement was found in the need for data security, health information, ease of use, fashionable look and discreet versus striking design in the medical contexts versus the sports contexts. The authors concluded that the devices must be usable in both technical aspects and daily living—for example, in relation to social comfort. There are different functional and aesthetic expectations with different device domains.

Similarly, Bodine and Gemperle (2003) examined the relationship between context of use and comfort. The researchers conducted an experiment with 41 Carnegie Melon university undergraduates, randomly assigning them to try on and move around in a backpack or armband that was assigned one randomly selected function: police monitor, medical-health monitor, or party-supply device. The same two objects were used in conjunction with each function condition. After measuring perceived comfort, the researchers found an effect from functionality: the police monitor condition was rated negatively in both objects (not useful in the armband; not "cool" in the backpack) and made participants feel more self-conscious and awkward. Interestingly, the police monitor function was also rated as less *physically* comfortable to wear than the other two functions. Alternatively, the medical monitor, which was rated positively in both objects, was rated as the most physically comfortable device. Both attitudes and physical experience with the devices were affected by the prescribed function.

Herath et al. (2011) also examined the effects of function and context on comfort, conducting a pilot study with 18 University of Sydney undergraduates who were instructed to wear a box-shaped wearable tracking unit on either the front or back torso. Students were given one of three functions and scenarios with a context-situating audio recording that described the wearable as either a drink cooling system used at a party, a tool for search and rescue missions, or an assistive device for dementia patients in a care facility. Again, the same device was used in all three conditions. Unlike Bodine and Gemperle (2003), they did not find a significant effect on physical comfort. They also did not find an effect on wearing location. However, the researchers did find significant differences in social desirability and acceptance ratings of the contexts. The search and rescue condition was deemed the most acceptable context for wearing the device, and the party condition was deemed the least. Herath et. al comment that the acceptability of the device was related to perceived usefulness, and possibly the level of "coolness" that the device would attribute to the wearer in the given contexts.

Observer Perspectives of Wearable Technologies

In the previously mentioned studies, function or context-of-use descriptions were provided to the participants before collecting the participants' judgements about the device. Similarly, each participant sample was explicitly made aware that they were evaluating a wearable technology. Reported opinions regarding function came from the first-person or user perspective and were influenced and possibly biased in some ways for this reason. Most wearable technology perception research uses the user/first person perspective during product evaluations—as many of these studies hope to obtain potential or current consumer wants and needs. Although this perspective is necessary and important to product design and evaluation, when reported opinions regarding function come from the first-person or user perspectives, they may be narrow, biased, or influenced to be more accepting. For example, studies have shown that subjects are more likely to positively perceive a device or activity when evaluating said device/activity from a user's point of view than from an outsider's point of view, though such findings are context dependent (Koelle, Kranz, and Moller, 2015). Third party perspectives and perception may differ quite a bit from those of a user or first person and can have just as much impact on a product's acceptance.

Perception is a process of discovery, identification, and knowing (DeLong, 1998) made possible through sensory input, past experience/memory, and available or learned information (DeLong, 1998; Myers, 1989). In public or private social settings, input and information is communicated explicitly and implicitly, intended or not, through verbal and nonverbal channel sources such as words, symbols, form, smells, body language, etc. Thus, everything, every person, object, behavior, location, and activity is imbued with meaning—meaning that is shaped by and requiring of interpretation (Blumer, 1969). The less explicit the information that is available, the more the subjects must rely on inference and interpretation. Third persons generally have the least amount of information in any given social setting.

When applying this understanding to the importance of third parties with limited information, there are a few distinct ways in which an observer has influence over product and persons. On product acceptance: one of the first stages of product diffusion is awareness, and though this stage is most often and easily facilitated through direct interaction with known individuals, it may also occur accidentally, for example, from observation of an unknown individual (Rogers, 2003). One of the first questions a newly aware person asks when observing an unknown technology is "what is it?," and awareness inspires interest and knowledge-seeking behavior which lead to potential adoption (Rogers, 2003).

In addition to product interest, one must consider the dynamic between the individuals (first and third persons) themselves. In the *Presentation of Self in Everyday Life*, sociologist Erving Goffman, (1959) compares social beings to actors and audiences engaged in a type of impression management and communication exchange. In a public setting (the theater stage), a first-person user (the actor) would be performing/presenting a public version of themselves with the assistance of objects (props) such as wearable technology to construct their desired image. Other individuals (the audience) are subject to the presentation and simultaneously affect the performance through their reaction. Actions and reactions by all parties are shaped by expectations of interpreted meanings, social normality, etc. (Goffman, 1959). If a third party misinterprets or does not agree with a publicly worn wearable technology, they may react negatively towards the wearer, thus causing the wearer to reconsider their behavior/product use in the future. Conversely, if the wearer expects a certain reaction from third parties, they may alter their behavior prior to experiencing the reaction. In this way, a third party may positively or negatively alter behavior.

Third party or bystander reactions are extremely important to the study of wearable technology products, especially publicly worn items, and should receive more focus

(Flammer, 2016). That is not to say that studies on or from a bystander or third person perspective do not exist in the literature. There are some important studies that have examined this topic and support the need for more research from the non-user's perspective.

In several first-person user studies that were carried out in public settings, bystander reactions were recognized by the study participants or researchers. Participants in these studies described experiencing odd looks, avoidance behavior, interest, or sometimes discontent from non-participants in reaction to the participants wearing interactive glasses (Lucero & Vetek, 2014), wearable cameras (Chowdhury, Ferdous, & Jose, 2016; Hoyle, 2016; Koelle, Heuten, & Boll, 2017; Price et al., 2017), video streaming glasses and forearm-worn devices (Procyk, Neustaedter, Pang, Tang, & Judge, 2014), light-up wristbands (Fortmann, Müller, Heuten, & Boll, 2014) and active game-displaying t-shirts (Puikkonen, Lehtiö, & Virolainen, 2011). In the news as well, users of Google Glass smart glasses have reported particularly negative reactions, such as verbal and physical attacks (Gross, 2014). In addition to these annotations made in first person studies are a few studies that have directly researched second or third-party opinions on various wearable technology devices.

Profita (2011) examined the third person perspective on social acceptability of different gestural interactions and body-placement interaction sites with a stitched wearable controller interface (a click wheel similar to a d-pad). American participants (20 to 59 years old) were asked to view a recording of two individuals riding an elevator together, one of which was simultaneously interacting with an on-body wearable interface. Profita found that certain gestures (sliding) were preferred over others, that device positioning on the body affected perceived social acceptability (e.g. the forearm was rated more positively than the torso), and that gender of the wearer interacted with body location to affect acceptability (e.g. the waist was rated more negatively for female device wearers). These third-party perspectives were examined to gain more insight into how wearables might be perceived in public settings and gleaned significant insight. However, it should be noted that all participants were informed that they would be examining a wearable controller before viewing the recording. Further, one criterion for study inclusion was fully understanding what the device was after the topic was introduced. In true public settings, third persons might not have access to such information or full understanding before forming an opinion.

In that regard, researchers from the University of Washington (Denning, Dehlawi, & Kohno, 2014) collected information on third party perspectives through paratyping methods conducted at twelve public cafes—wherein which one researcher wore augmented reality (AR) glasses in the cafes and another researcher interviewed a total of 31 observing bystanders (18 to 75 y.o., 42% female). Their interview questions began with first asking the bystanders whether, and what, they had noticed about the product, and then whether they had known there were electronics in the glasses, before providing information about the glasses and asking opinions on such recording devices. According to the authors, only approximately 36% of those interviewed had *not* noticed the glasses. After discussing the glasses, bystanders expressed mostly indifferent or negative opinions about the glasses, with opinions reportedly dependent on who was wearing the device, where the recording was occurring, what the bystander was doing while being recorded, if they would be identified in the imagery, if the scenario would interrupt their activities, and whether/how permission for recording would be obtained. Unfortunately, information regarding what bystanders believed the glasses to be, before topics of recording and acceptance were discussed, was not included in the paper. The authors concluded with several design ideas for related products, such as implementing visual cues to indicate when the glasses are recording,

Other researchers, Nguyen et al. (2009) and Singhal et al. (2016) have similarly conducted paratyping, bystander-focused studies. Each also found that perceptions on acceptability of wearable recording devices were dependent on the purpose of the recording, the behavior/appearance of the bystander being recorded, the location where the activity was happening, the breadth of accessibility to the recording by others, and whether consent was part of the interaction. In these two studies, as with the others previously mentioned, before surveying the bystanders the researchers provided the device type and then commenced with questioning. Perception on what the device was first assumed to be was not listed as one of the aspects questioned.

Noteworthy, in the study by Nguyen et al (2009), the product was said to be described to the observers as an assistive technology, which may have further altered the bystander's assumptions and then feedback (bystanders tended to be accepting of the device, given its purported need). This latter detail, however, points to the importance of the perceived device function on the perception of acceptability. The researchers stated that interviewees felt that some visual cues indicating that the device was an assistive technology should be implemented in the design: bystanders who observed the wearable medical camera felt negatively about the product's bulkiness, wishing it were more "aesthetically pleasing," yet they also recognized the utility of the size in making visible the possibly contentious functions of a recording device. They suggested adding additional symbols to overtly indicate its medical necessity (Nguyen, 2009).

Koelle, Kranz, and Moller (2015) conducted focus groups in Munich to garner first and second person perspectives on the usage of data glasses versus smartphones in a variety of scenarios, using pictures as stimuli. Again, the 38 participants (aged 18 to 38, 16% female) in the study were told what the purpose of the study was prior to the questioning, and were then shown pictures depicting a user with either the smartphone or data glasses in 14 different work or public-setting scenarios. Half of the participants were able to see what the device was explicitly being used for in the given scenario, and half were not. However, all participants were told what devices they were observing. Concerns regarding the devices included privacy issues and freedom of choice to use said device, and differences between glasses and smartphones were recorded (smartphones, which were seen as more familiar, were rated more positively).

Most important to the study under hand is that Koelle, Kranz, and Moller (2015) found significant differences between first person (the reader as the user of said device) and second person (the reader as the person near or interacting with the user of said device) perspectives, and significant differences between those who were given information on what the device was being used for and those who were not. Social acceptance ratings were more negative when the device was being used by a second person versus a first person in work-environment scenarios, and when there was no information about the context of use in several of the public setting scenarios. Thus, the bystander's perceptions on a device's context of use requires more study.

In general, research on bystander perspectives or bystander considerations pertains almost exclusively to the privacy concerns of wearable recording devices. Further, when individuals are interviewed, they are almost always first informed that they are providing feedback on a wearable technology device and the specific functions. However, one study—although still on the topic of data glasses—studied both the presentation of the device, appearance of the device user, and perceived function of the device, from the perspective of the informed (device purpose known) and uninformed (device purpose unknown) bystander. Profita, Albaghli, Findlater, Jaeger, and Kane (2016), explored context of use from a bystander perspective in the presentation of Google Glasses as either simply smart glasses or as an assistive technology to 1,200 US-based Mechanical Turk participants. The participants were randomly assigned to view one of two videos: either a Google Glass user walking in a public setting using the glasses, or, the same Google Glass user whose appearance was manipulated to portray a visual impairment with the addition of dark glasses lenses, and a white walking cane (aside from the lenses, the color of the glasses was not altered). Profita et al., (2016) found that the manipulated appearance altered bystander evaluations.

In the disability scenario, participants rated the Google Glasses as more normal, more appropriate, more useful, less unnecessary, and less distracting than in the non-disability condition. Perception of the device also affected evaluation of the glasses user; the user was seen more positively and less nerdy in the disability scenario. It is important to consider how a device is perceived, as that perception may negatively or positively affect perceptions not just of a product, but of the person wearing it.

There is evidence in the literature pointing to the importance of perceived domain or function on positive or negative perceptions of wearable technology and technology wearer. Similarly, there is some evidence that color is a cue used by observers in interpreting a wearable device's function or purpose. Such a relationship indicates that color may then be an influencing variable on the social acceptability of wearables and users. However, first, a more thorough look at domain perceptions must be investigated to establish potential relationships. There are multiple reports documenting trends relating common product forms and even body locations to common domains, but there is very little research on color. Hence, the following research questions are posed:

Research Questions

1. How does body-worn form influence the perceived domain(s) of wearable technology products?
2. To what degree does color influence the perceived domain(s) of body-worn wearable technology products?

Chapter III

Methods

To test whether color and form would affect perceived device functionality, first, two pilot tests were developed. In each test, a set of devices worn in different body locations was presented in a variety of colors and shown to participants who were asked to select the product's assumed function. The devices selected for the studies were chosen with the aim for variety in product form, location, and function, and limited to accessories/gadgets, rather than clothing, to represent the wearables market trend towards accessories over garments (Berglund et al., 2016). Further, devices with multiple advertised domains were selected to determine whether color would sway the assumed domain, given the actual possibilities. A variety of products were chosen to determine whether any colors have associative meanings across varying types of wearable technology accessories, or whether trends are product specific.

Product Selection and Function

The following wearable devices (excluding the exoskeleton arm support) were selected from the Vandrico Solutions, Inc. Database [2] of wearable technologies: an armband activity monitor, a pair of smart glasses, an augmented reality headset, an armband remote-gesture band, and a neurostimulation asymmetrical headband. The activity monitor, smart glasses, and augmented reality headset were chosen to represent the most commonly studied and marketed wearable technology devices. Additional devices were chosen to expand product variety—such as the asymmetrical headband, and the remote-gesture band. In addition, exoskeleton devices are forecasted to increase by 30% in the next four years ("Global Robotic Exoskeleton," 2018)—thus, an exoskeleton arm support was included. The arm support was found through a preliminary web search, as Vandrico's database did not include such a product. Additionally, the biggest and most well-known brands (e.g. FitBit, Pebble, Google, etc.) were excluded from selection to avoid potential brand recognizability and bias. **See Table 1.**

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[2] www.vandrico.com

Table 1. Product Selection

Wearable Device	**Advertised Domain**
BodyMedia Link Armband  https://vandrico.com/wearables/device/BodyMedia-link-armband	Fitness and Lifestyle *"a wearable activity monitoring device that analyzes the body activity for health and fitness purposes."* (Vandrico, 2018)
Chipsip Sime Smart Glasses  https://vandrico.com/wearables/device/chipsip-sime-smart-glasses	Industrial, Gaming, Lifestyle, Medical and Entertainment *"provide real time information for anyone in any environment…includes function of image recognition, smart connections and environment senescing…to increase…productivity, communication and information gathering"* (Vandrico, 2018)
Cyberdyne Hal Arm Support  https://www.cyberdyne.jp/english/products/SingleJoint.html	Medical and Non-Medical body training and support *"used for any arm…joints and specialized in intensive training."* (Cyberdyne, 2018)
Meta 2 Augmented Reality Headset  https://vandrico.com/wearables/device/meta-2-augmented-reality-headset	Entertainment, Gaming, Lifestyle and Industrial *"intended for developers, artists, creators and makers that provides neuroscience driven interface design that allows for the collaboration, manipulation and sharing of digital information."* (Vandrico, 2018)

Thalmic Labs Myo Armband   https://vandrico.com/wearables/device/thalmic-labs-myo-armband https://www.gizmodo.com.au/2015/08/myo-armband-australian-review/	Entertainment, Gaming and Lifestyle *"a gesture control device … using gesture control, the user can interact with a number of other electronics, hands-free."* (Vandrico, 2018)
Thync Bioelectronic Headgear  https://vandrico.com/wearables/device/thync	Lifestyle "*wearable device which uses low level electrical pulses to stimulate or calm neural pathways…which helps users manage their stress levels*" (Vandrico, 2018)

Image Stimuli and Color Application. For the study, pictures of the products were created with Adobe Photoshop and Optitex CAD software**.** Each device was Photoshopped and positioned onto a 3D rendered male figure that was prototyped on Optitex. To control for any possible influences of skin tone on evaluation, the figure was rendered in a neutral light gray color. The appearance of the figure was created to mimic a retail mannequin.

Product names and symbols were removed from the images to prevent possible bias. Products were then Photoshopped in the following 11 colors: black, white, grey, blue, green, purple, red, pink, orange, yellow, and beige. The 11 colors were selected to include a comprehensive (though not exhaustive) color selection**,** including standard colors typically found on a color wheel, while also including black, white, grey, and beige to investigate for similarities in past literature findings, and because the products are already pictured in black, white, and greys.

Saturation was kept constant in all colors, except where Photoshop manipulation obstructed device design visibility. In such cases, the color was adjusted until image consistency in material and design features were obtained. Counting each color-product combination as a separate entity, there were a total of 66 devices. **See Appendix A.**

Domain/Function Variables. Because product function is often dictated by a product's intended domain/market area, domain types were selected, rather than specific functions. This helped simplify selection options. Each device was listed with 10 product domains with accompanying domain definitions for product categorization. The following product domains were included: Fashion, Gaming & Entertainment, Health & Wellness, Industry, Lifestyle, Medical, Military, Security/Safety, Sports & Fitness, and Other, please describe. These domains were selected after reviewing the domain categories listed on Vandrico and the findings reported by researchers of wearables trends, such as Berglund et al. (2016) and Silina and Haddadi (2015). Definitions were written by the researcher. **See Table 2.**

Table 2. Product Domains

Domain	**Definition**
Fashion	used for aesthetic purposes
Gaming & Entertainment	used for recreational and entertainment purposes
Health & Wellness	used by an everyday person to promote their health
Industry	used by someone to perform their job, usually in the production of goods or services
Lifestyle	used for general, day-to-day tasks
Medical	used by doctors or patients for medical reasons
Military	used by military personnel for the purposes of training or combat
Security/Safety	used for protection
Sports & Fitness	used to assist in the performance of athletic activities
Other	please describe

Pilot Survey Design

A survey was created using Qualtrics Online Survey Software and consisted of eleven 'device' survey blocks. Each device block contained one of each of the six main products, randomly ordered, each in a randomly selected color chosen from the eleven colors listed above. A survey participant would only see and rate 6 of the 66 product-color combinations. Each device was presented on a separate page that asked survey takers to select the product domain they believed the object 'most likely belonged to'. The 10 domain options were randomly ordered and multiple selection was allowed. The participants were not given any information regarding what the devices were or what they did, and the participants were asked to make their selection based on the image alone as the aim was to understand a possible observer's assumptions about these products. Each survey also contained one attention check to filter for blind selection. **See Appendix B.**

The survey was listed on several survey swap websites (e.g. Reddit.com/r/samplesize, swapsurvey.com, etc.); however, participation was low (n=21) in comparison to time listed online. Consequently, the survey was listed on Amazon's Mechanical Turk at $0.25 a HIT (human intelligence task) and data from the previous 21 non-MTurkers (Mechanical Turk workers) was excluded from planned analysis to control for population differences.

Mechanical Turk was selected for the timely and cost-effective recruitment of participants (Buhrmester, Talaifar, & Gosling, 2018). Mechanical Turk has been said to elicit better quality data than online convenience sampling that relies on advertisements (versus direct task sourcing) to recruit respondents (Antoun, Zhang, Conrad, & Schober, 2016) and comparable quality data to in-person convenience sampling of students or community members (Necka, Cacioppo, Norman, & Cacioppo, 2016). Further, concerns about drop-outs, attention problems, or dishonesty, etc. may be quelled with simple directions, accurately estimated task time, and worker qualification filtering, etc. (see Buhrmester, Talaifar, and Gosling 2018; see Goodman & Paolacci, 2017).

Additionally, an internet-based sample was deemed acceptable for recruitment of participants, as 90% of US adults are internet users (Anderson, Perrin, Jiang, & Kumar, 2019) and 77% are daily users (Perrin & Jiang, 2018). Location was limited to the US to help control for cultural differences in color associations. In addition, age was restricted to 18 years or older, due to Amazon's legal hiring terms.

Worker qualifications also specified that the worker have >100 HITs approved to work on the task. The listing was also designed so that MTurkers were prohibited from taking more than one survey. Thus, each MTurker saw only one of each product. This restriction was imposed to reduce product and color overexposure, and to garner more organic product reactions and color associations.

Pilot Sample Demographics

The entire recruited sample consisted of 270 MTurkers after 41 submissions were excluded due to drop-outs and attention check failures. The sample was 55% male and the mean age was 35 (sd=10.63). Specific sample sizes are given in the results. Due to the random presentation of product blocks, sample sizes (i.e. the viewing participants per set of 6 products) differed from 21 to 29 MTurkers. Other demographic factors were not asked of participants in the pilot study.

Color blindness was not assessed for the pilot test. Color blindness, or color vision deficiency, makes certain colors that would be distinct colors to those without a deficiency appear indistinguishable. There are three main types of color vision deficiencies found in humans: red-green, blue-yellow, and complete color blindness, and according to the National Eye Institute (2015) and the US National Library of Medicine's Genetics Home Reference (2015) approximately 8% of men and less than 1% of women (.05%) are affected by the red-green color blindness. Blue-yellow color blindness is less common (<.01%), and complete color blindness is described as even more rare. Given the small probability of recruiting participants with color blindness and taking into consideration the need for simple and timely data collection for the purposes of a pilot study, color blindness was not measured.

Analysis and Top Domains

One of each product-color combination (one color from each of the six products) was presented to participants, who were asked to identify the most likely associated product area. Ten domains were available for selection, and multiple selection was possible. As such, each domain selection was recorded as a proportion of sample selection. Each product-color domain selection was graphed as a percentage of sample selection (out of 100%), for better comparison between products with varying sample sizes.

For the pilot study, a frequency count and randomization test method of analysis were used to identify the "Top Domains" associated with the products displayed to participants. With each product, the most selected domain (the highest frequency count) was deemed the Top Domain. Subsequent domain counts were then compared to The Top Domain. Counts were analyzed with a number of randomization tests for differences in proportions. A randomization test compares two ratios to estimate the likeliness of the count selection differences occurring by chance. A randomization test was selected for analysis because the data (sample sizes) did not meet the assumptions of more traditional tests, such as t-tests, which require either a large sample size or minimal sample variation. Randomization tests for differences in proportions allow for more sample variance and for smaller sample size comparisons, with the trade-off being lengthier time and more computational power to process the data than traditional tests.

Given the large amount of data, the randomization tests were used to analyze only the most selected domains against the remaining nine domains (equaling 9 tests per product-color), rather than all domain permutations possible (45 tests per product-color). In these comparisons, domains which were *not* significantly different from the Top Domain (in each product), would also be considered Top Domains for that product. The randomization tests were run as a two-tail analysis and statistical significance was determined at the standard p-value of 0.05.

Pilot Test 2 Design and Consideration

A second pilot test was created to ascertain whether more explicit color associations might be present and to control for the sample variance that was inherent in Pilot 1. In the second study, participants were informed to select domain choices specifically with color in mind. The aim was to see if clearer selections would be present, with those results being used to down select the number of colors in a final iteration survey that would be designed in the same manner as Pilot 1 (study aims not disclosed). The survey was again created with Qualtrics Survey Software. In Pilot 2, each survey consisted of only 1 device but in all eleven colors, with the product-color combinations randomly ordered. Six surveys, one for each product, were created. Each survey contained one attention check question.

In Pilot 2 each of the six product types were rated by a collective sample. The survey was disseminated through Mechanical Turk for $0.50 a HIT and made available to US residents age 18 and older. MTurkers were prohibited from taking the same (product) survey more than one time, but not from taking a survey on one of the remaining five devices. MTurkers were required to have >100 prior HITS approved to qualify for the survey.

The total number of participants equaled 198, collectively. The sample size for each are listed: Activity monitor (n=36 after 9 failed attention checks), smart glasses (n=36 after

9 failed attention checks), exoskeleton arum support (n=27), augmented reality headset (n=36 after 11 failed attention checks), gesture band (n=36 after 14 failed attention checks), and headband (n=27).

Pilot 2 was analyzed in the same manner as Pilot 1: with randomization tests for differences in proportion. Results were graphed for each product-color to visualize the domain trends, and domain selection proportions were then analyzed with randomization tests to determine the highest frequency domain choice(s) and Top Domains for each product. **See Appendix C.**

Ultimately, however, the results for Pilot 2 were deemed unusable for further study. Although some findings in Pilot 2 mirrored Pilot 1, in general results for Pilot 2 were less clear. This was speculated to be due to spurious effects from stimuli overexposure. Further, limitations in the stimuli (used in both pilots) were discovered—which made revisions necessary. Therefore, because the planned next steps mimicked the methods of Pilot 1 (study aims not disclosed), and Pilot 1 results were clearer than Pilot 2 results, only Pilot 1 results will be presented and utilized.

Pilot Test 1 Results

Every product-color combination was viewed between 21 to 29 times, depending on the specific product's sample size. Selection counts are presented in the results as percentages (ratio of participants who selected the domain) for easier comparison between products with different sample sizes. Domain selection in each color ranged from 0 to 100%. Below, each product and color are presented and discussed. Across all colors for each product, there were often one or two commonly chosen most selected Top Domains, with variation in the subsequent Top Domain choices. Those products with the least amount of variation, or differences between colors, will be discussed first.

Armband Activity Monitor. With the activity monitor, there was the least amount of variation between different colors. In nine out of eleven colors (blue, green, grey, beige, orange, pink, purple, white, and yellow), Sports & Fitness (S&F) and Health & Wellness (H&W) were both selected as the top perceived product domains. In black, S&F was the only Top Domain— selected significantly more times ($p<0.05$) than all other choices, although the trend line in the count of the remaining selections showed similarities to the previous colors. In red, H&W, Medical, and S&F were all Top Domains (not significantly different from one another). Thus, S&F was a Top Domain in every color, H&W in ten out of eleven, and Medical in one color. Participants believed the product to be a S&F and H&W product.

The single most selected domain in each color (which alternated between S&F or H&W, was always selected by >62% of the viewing participants, with subsequent top domains selected by at least 46% ($\bar{x}$=59%) of the participants. Additionally, on average, the remaining domains had a very low selection count, save for Medical, which often ranked in the 30-percentile range, yet was selected significantly fewer times than S&F and H&W in ten out of the eleven colors. There appears to be a consistent perceived association between product and domain, but a solid difference between colors was not observed. Whether color had a strengthening or weakening influence over selections in black or red is unclear. **See Tables 3-4 and Appendix D.**

Table 3. Activity Monitor Top Domains

Color	Top 1st	Top 2nd	Top 3rd
Black	S&F		
Blue	H&W	S&F	
Green	S&F	H&W	
Grey	H&W	S&F	
Beige	H&W	S&F	
Orange	S&F	H&W	
Pink	S&F	H&W	
Purple	S&F	H&W	
Red	H&W	Medical	S&F
White	H&W	S&F	
Yellow	H&W	S&F	

Table 4. Activity Monitor Top Domains Reorganized by Domain Frequency

Color	S&F	H&W	Medical
Black	S&F		
Blue	S&F	H&W	
Green	S&F	H&W	
Grey	S&F	H&W	
Beige	S&F	H&W	
Orange	S&F	H&W	
Pink	S&F	H&W	
Purple	S&F	H&W	
Red	S&F	H&W	Medical
White	S&F	H&W	
Yellow	S&F	H&W	

Exoskeleton Arm Support. In the arm support, there was again, a common selection of Medical, H&W, and S&F domains observed across different colors. Medical was the most selected domain in every color version of the device, sometimes as a single Top Domain, and sometimes in combination with the aforementioned choices. It was also always selected with a majority vote (>57%). In seven colors (blue, green, orange, purple, white, and yellow), Medical was selected significantly ($p<0.05$) more times than all other domain choices as the single Top Domain, by 64-83% of the participant sample. However more variation was seen between colors than in the activity monitor. In beige and red, the Top Domains for the exoskeleton arm were Medical (59% and 58%, respectively), H&W (46%; 42%), and S&F (32%; 35%). In black, the Top Domains were Medical (66%) and S&F (41%); in pink they were Medical (73%) and H&W (46%); and in grey, the top domains were Medical (58%), H&W (38%), and Military (33%).

Looking both at the Top Domain significance, and the percent of selection by participants, it is clear that the arm support is perceived overwhelmingly as a Medical device. Yet, color differences were observed in the secondary Top Domain selections. There is an obvious overlap between the Medical and H&W fields, thus this intersection is not unexpected**.** Most distinct are the colors which ignited a S&F (black, red, and beige), and a Military (grey) assumption. **See Tables 5-6 and Appendix D.**

Table 5. Arm Support Top Domains

Color	Top 1st	Top 2nd	Top3rd
Black	Medical	S&F	
Blue	Medical		
Green	Medical		
Grey	Medical	H&W	Military
Beige	Medical	H&W	S&F
Orange	Medical		
Pink	Medical	H&W	
Purple	Medical		
Red	Medical	H&W	S&F
White	Medical		
Yellow	Medical		

Table 6. Arm Support Top Domains Reorganized by Frequency

Color	Med	H&W	S&F	Military
Blue	Med			
Green	Med			
Orange	Med			
Purple	Med			
White	Med			
Yellow	Med			
Black	Med		S&F	
Pink	Med	H&W		
Red	Med	H&W	S&F	
Beige	Med	H&W	S&F	
Grey	Med	H&W		Military

*Colors reordered for grouping

Armband Gesture Band. The gesture band also had fairly consistent domain selections, with some select color variation. In the colors green and pink, the Top Domains selected were S&F (71% and 52%, respectively) and H&W (48%; 48%). In black, blue, beige, purple, red, and yellow, the Top Domains were H&W ($\bar{x}$=42%) and S&F($\bar{x}$=39%), with the addition of Fashion ($\bar{x}$=47%) as the most selected domain, and in white, the Top Domains were Fashion (50%), H&W (35%), S&F (35%), and Medical (23%). In grey, the Top Domains were Fashion (46%), H&W (41%), S&F (32%), Medical (18%), and Lifestyle (18%).

In this product, a common selection across almost all colors occurred, with the domain choices H&W, S&F, and Fashion—suggesting again, a stronger association between product and domain over color and domain. In every single color, H&W and S&F were Top Domains; in nine colors, Fashion was also a Top Domain**.** Additionally, in the colors, orange, white and especially gray, multiple perceived domains were selected by the participants. However, the most selected domain had less consensus (smaller selection count) than in most other colors—suggesting possible color influence related to the additional domains, or negative influence on the most selected domain. Similarly, in green and pink, these colors may have had a negative influence on the Fashion selection. **See Tables 7-8 and Appendix D.**

Table 7. Gesture Band Top Domains

Color	Top 1st	Top 2nd	Top 3rd	Top 4th	Top 5th
Black	Fashion	H&W	S&F		
Blue	H&W	S&F	Fashion		
Green	S&F	H&W			
Grey	Fashion	H&W	S&F	Medical	Lifestyle
Beige	Fashion	S&F	H&W		
Orange	H&W	S&F	Fashion	Medical	
Pink	S&F	H&W			
Purple	S&F	H&W	Fashion		
Red	S&F	H&W	Fashion		
White	Fashion	H&W	S&F	Medical	
Yellow	Fashion	H&W	S&F		

Table 8. Gesture Band Top Domains Reorganized by Domain Frequency

Color	H&W	S&F	Fashion	Medical	Lifestyle
Green	H&W	S&F			
Pink	H&W	S&F			
Black	H&W	S&F	Fashion		
Blue	H&W	S&F	Fashion		
Beige	H&W	S&F	Fashion		
Purple	H&W	S&F	Fashion		
Red	H&W	S&F	Fashion		
Yellow	H&W	S&F	Fashion		
Orange	H&W	S&F	Fashion	Medical	
White	H&W	S&F	Fashion	Medical	
Grey	H&W	S&F	Fashion	Medical	Lifestyle

*Colors reordered for grouping

Smart Glasses. Many domains gained Top Domain status in the smart glasses product, but four main domains were present in most color versions of this product: Gaming & Entertainment, Industry, Medical, and Military. In black, the smart glasses were perceived as a G&E device above all other domain options ($p<0.05$). In every color version of the smart glasses, G&E was a Top Domain. The G&E domain was also the most selected choice in nine out of the eleven colors. See Tables 9 and 10 below to review domain selection combinations in the remaining ten colors.

G&E had a >54% selection rate (54 to 69%) in all colors except green (48%), pink (46%), beige (36%) and yellow (33%). The majority of the other colored glasses were also associated with Industry, which was a Top Domain in nine colors; with Medical, a Top Domain in eight colors; and with Military, which was a Top Domain in seven colors. Lifestyle and Security, however, were Top Domains in very few colors (three and one, respectively). Again, the different assumed domains found for certain colors were interesting and not expected, with a smaller maximum count selection in many colors compared to previous products. Further, though G&E was a Top Domain in all colors, its count range across colors was wide, suggesting possible color influence. **See Tables 9-10 and Appendix D.**

Table 9. Smart Glasses Top Domains

Color	Top 1st	Top 2nd	Top 3rd	Top 4th	Top 5th
Black	G&E				
Blue	G&E	Industry	Medical		
Green	G&E	Lifestyle	Industry	Medical	Military
Grey	G&E	Medical	Military		
Beige	Industry	Medical	Military	G&E	
Orange	G&E	Lifestyle	Industry	Medical	Military
Pink	G&E	Industry	Medical	Military	
Purple	G&E	Industry			
Red	G&E	Industry	Lifestyle		
White	G&E	Military	Industry	Medical	
Yellow	Military	Industry	G&E	Medical	Security

Table 10. Smart Glasses Top Domains Reorganized by Domain Frequency

Color	G&E	Industry	Medical	Military	Lifestyle	Security
Black	G&E					
Purple	G&E	Industry				
Blue	G&E	Industry	Medical			
Grey	G&E		Medical	Military		
Red	G&E	Industry			Lifestyle	
Beige	G&E	Industry	Medical	Military		
Pink	G&E	Industry	Medical	Military		
White	G&E	Industry	Medical	Military		
Green	G&E	Industry	Medical	Military	Lifestyle	
Orange	G&E	Industry	Medical	Military	Lifestyle	
Yellow	G&E	Industry	Medical	Military		Security

*Colors reordered for grouping

Neurostimulation Headband. Medical was the most highly assumed product domain area, followed by Health & Wellness, in the headband product. Different domains were found in only a select few colors. Medical was a Top Domain choice in every color of the headband product, and the most selected domain in ten colors. Further, the selection count for the Medical domain included the majority of the viewing participant sample (54 to 73%) in all colors except yellow, black, beige, and purple (41 to 46%). H&W, in general was selected by more than 30% of the participants (35 to 48%) as a Top Domain Choice, except in black (24%) and in yellow (29%)—where Medical's selection counts were also smaller. Further, the trend lines for H&W were similar even when it was not a Top Domain (i.e. in red, pink, white). This indicates similar trends at least in subsequent domain assumptions.

Overall the headband device was perceived to be a medical/health device, but in certain colors there were weaker Medical and H&W selections observed, and thus additional Top Domains observed. Purple, black, and beige showed the most variation in Top Domain range: Lifestyle was a Top Domain in three colors (purple, black, and beige), G&E in two colors (purple and black), Military in two colors (black and beige), and Industry in one color (beige). S&F was also a subsequent domain in only one color (yellow). Further, in these colors, there was no single Top Domain (Medical or otherwise) that was selected by a sample majority (i.e. >50%). These selection results were less concise. **See Tables 11-12 and Appendix D.**

Table 11. Headband Top Domains

Color	Top 1st	Top 2nd	Top 3rd	Top 4th	Top 5th
Black	Medical	Military	Lifestyle	Health	G&E
Blue	Medical	H&W			
Green	Medical	H&W			
Grey	Medical				
Beige	H&W	Medical	Lifestyle	Industry	Military
Orange	Medical	H&W			
Pink	Medical				
Purple	Medical	H&W	G&E	Lifestyle	
Red	Medical				
White	Medical				
Yellow	Medical	S&F	H&W		

Table 12. Headband Top Domains Reorganized by Domain Frequency

Color	Medical	H&W	Lifestyle	G&E	Military	Industry	S&F
Grey	Medical						
Pink	Medical						
Red	Medical						
White	Medical						
Blue	Medical	H&W					
Green	Medical	H&W					
Orange	Medical	H&W					
Yellow	Medical	H&W					S&F
Purple	Medical	H&W	Lifestyle	G&E			
Black	Medical	H&W	Lifestyle	G&E	Military		
Beige	Medical	H&W	Lifestyle		Military	Industry	

*Colors reordered for grouping

Augmented Reality Headset. The most Top Domains observed in the domain perception task (of all six wearable technology products) were those found in the augmented reality (AR) headset product. Gaming & Entertainment and Industry were the predominant selections across almost all color versions of the AR device. Further, G&E was a Top Domain in every color of the product, and the most selected domain choice in nine of the AR colors. In all colors except red, G&E was selected by >50% of the participants; in red, G&E was a Top Choice, but not the most selected domain (31%). Again, a wide range of selection counts was seen across colors for this consistent perceived domain.

Industry was a Top Domain in all colors of the AR headset ($\bar{x}$=40% selection rate), except in the white and the beige versions of the product. About half of the colors were also perceived as likely Military (beige, orange, yellow, pink, black, and red; 23 to 48%) and Security products (blue, purple, pink, black, and red; 23 to 38%). In the colors grey (35%) and black (32%), Medical was also a Top Domain, and in red (23%), S&F was another Top Domain. Much lower counts were seen in some augmented reality colors, as the most selected domain was also lower in count/not as strongly perceived. **See Tables 13-14 and Appendix D.**

Table 13. AR Top Domains

Color	Top 1st	Top 2nd	Top 3rd	Top 4th	Top 5th
Black	G&E	Security	Medical	Industry	Military
Blue	Industry	G&E	Security		
Green	G&E	Industry			
Grey	G&E	Industry	Medical		
Beige	G&E	Military			
Orange	G&E	Military	Industry		
Pink	G&E	Military	Industry	Security	
Purple	G&E	Industry	Security		
Red	Industry	Security	G&E	Military	S&F
White	G&E				
Yellow	G&E	Industry	Military		

Table 14. AR Top Domains Reorganized by Domain Frequency

Color	G&E	Industry	Military	Security	Medical	S&F
White	G&E					
Green	G&E	Industry				
Beige	G&E		Military			
Blue	G&E	Industry		Security		
Grey	G&E	Industry			Medical	
Orange	G&E	Industry	Military			
Yellow	G&E	Industry	Military			
Purple	G&E	Industry		Security		
Pink	G&E	Industry	Military	Security		
Black	G&E	Industry	Military	Security	Medical	
Red	G&E	Industry	Military	Security		S&F

*Colors reordered for grouping

Product Domain Selection Summary

A chart was created to summarize the previous findings. Products were also grouped by their relative body locations (e.g. arm) and product form similarities (e.g.

armband). The summary allows a comparison between products for Top Domain findings. No common color-domain selections were observed in all six products. One common domain, however, was observed across all six products: Medical was a Top Domain in all six wearable technologies in at least one color. Some color-domain similarities were found by body location grouping, but more dominant were the similarities in domain selection: in all arm-worn products, Medical, S&F, and H&W were selected in at least one or more colors. In all head-worn products, Medical, G&E, Industry, and Military were selected in at least two or more colors. **See Table 15.**

Table 15. Product-Domain Summary Comparisons

			Lifestyle	G&E	Industry	Military	Sec	Med	S&F	H&W	Fashion
Arm location	**Arm band**	**Activity monitor**	x	x	x	x	x	+red	+all	+all -black	x
		Gesture band	+grey	x	x	x	x	+orange +white +grey	+all	+all	+all -green -pink
	Arm cover	**Exo arm support**	x	x	x	+grey	x	+all	+black +red +beige	+pink +red +beige +grey	x
Head location	**Eyewear**	**Smart glasses**	+red +green +orange	+all	+all -black -grey	+all -black -purple -blue -red	+yellow	+all -black -purple -red	x	x	x
		AR headset	x	+all	+all -white -beige	+all -white -green -blue -grey -purple	+blue +purple +pink +black +red	+grey +black	+red	x	x
	Band	**Headband**	+purple +black +beige	+purple +black	+beige	+black +beige	x	+all	+yellow	+all -grey -pink -red -white	x

"+"=observed only in this color; "-" =observed in all colors except this color

Pilot Discussion and Limitations

Between the six products, there were no obvious observed trends in color-domain associations, but there were trends in domain selection. In all products, the domain Medical was a Top Domain in at least one color, and often in more than one color. There were also some Top Domain similarities in product groupings (e.g. H&W, S&F in the arm worn products). Similarly, there were some color-domain similarities in grouped products, but results were less distinct given the number of colors in which each domain was regularly selected.

Despite the minimal color trends between different products, it does appear that color may have some effect on perceived product domain within a product. Even for those which did not result in domain differences there is implication of certain colors having a stronger association to a single domain than other colors for a product (e.g. 58% Medical in red arm support versus 83% Medical in white arm support). However, Top Domains were not compared for significance across colors (e.g. Medical in red vs Medical in white) but only within domain options (e.g. Medical vs Sports, etc.). Additionally, significance was only determined by comparing domains to the most selected choice in every product, but not between any subsequent choices. This method excludes other domains that may have been selected by a majority of participants, but selected significantly fewer times than the most selected Top Domain. Comparisons between all domains should be conducted to fully assess selections and relationships. Additionally, though there appear to be some observed color effects on product evaluation, before an in-depth discussion or further analyses on observed color differences and possible influence can occur, more pressing limitations of this pilot study need first to be addressed and redressed.

First, computer screens were not controlled. After viewing the stimuli on different computer monitors, the researcher realized that different screens did not accurately display the intended color. For example, pink sometimes appeared orange in color on different computer monitors. Given the nature of the online survey, there is little that can be done to ensure consistency in the computer screen's visual displays used by all participants. Therefore, an improved study would use colors which had more monitor-transferable accuracy, and would implement instructions informing participants to adjust their monitor settings to best see and evaluate images.

On this note, it was also realized that there was not enough control on the colors themselves. The particular hues selected to represent each color were selected purely subjectively based on experienced visual representation. Further, though saturation was supposed to be kept constant for each color, certain product images had more visual texture or detailed lighting and required more adjustments in color application in order to keep the design of the object visible beneath the color layer. A look at the RGB values showed that the colors' characteristics were not kept constant across products. Considering the central importance of this variable, better control is required for color application. It is difficult to make strong conclusions about any color influences observed in the pilot test without such control and consistency.

Further limiting the validity of the pilot study were sample characteristics. For instance, for the reasons mentioned in the methods, color blindness was not assessed for the pilot study. The percentage of colorblind individuals in the United States is knowingly small; nonetheless, this small probability is less ensured in a non-randomly selected sample. Color blindness should be assessed and filtered in the next study iteration.

The sample sizes of the pilot study were also restrictive. It is difficult to make strong statistical conclusions with small sample sizes. Each product was viewed by less than 30 individuals. Because of the random presentation style of this study—wherein each product is viewed by a different sample and thus variance is increased—it is imperative to also increase the sample size for better statistical conclusions. Additionally, more demographic homogony could help control for both the size of each participant group and the variability inherent across samples. For instance, given the known effect of age on sight, and the disparate count sizes between younger and older participants in the pilot, analyses would be benefited if future samples are limited to one generation.

Survey Redesign and Methods

Following the findings and limitations of the pilot tests, revisions were made to the study methods and design. New colors were selected, product-stimuli were winnowed to a narrower set, participant recruitment changes were made, and more in-depth analyses were conducted.

New Color Selections. Given that Photoshop uses an RGB color scale, the new colors for the final surveys were selected from an online RGB color naming survey

(Munroe, 2010) in which 222,500 participants reviewed RGB color swatches from personal computers (90% LCD monitors) and responded with their subjective knowledge of the colors' given name. The researchers collected more than five million color name submissions, standardized the spellings (e.g. grey vs gray), and used a stochastic hillclimbing algorithm and geometric mean to find almost 1,000 colors with consistent naming. A palette of 954 RGB values and their most agreed on color names were published. And, although the survey was completed in 2010, recent publications continue to utilize the palette and names in color application or detection (Lindner & Susstrunk, 2015; McMahan & Stone, 2015; Seresinhe, Preis, & Moat, 2015; Stearns, Findlater, & Froehlich, 2018).

Further, though computers have improved in recent years, which may affect display settings, current computers still predominantly use LCD monitors, and statistics reported on computer color display from 2000 to 2016 found little variance in the common graphics bit/color depth between 2010 and 2016 ("Browser Display Statistics," 2019). Therefore, the Munroe (2010) palette was deemed acceptable for color selection in the survey redesign.

The RGB values from Munroe's (2010) palette were selected for the following color names: white, black, green, blue, pink, purple, orange, yellow, and beige. The color grey was not included in the redesign, as this color was too visually close to the neutral gray of the mannequin and thus any grey products appeared, in comparison, colorless.

In the pilot, colors were adjusted to allow object shading and design lines to remain visible, which negatively affected color characteristic (specifically RGB) control. Thus, in the final design, colors were Photoshopped in separate sections for shaded and non-shaded areas. Non-shaded areas were Photoshopped to match the RGB values selected from the Munroe (2010) color palette and maintained, while shaded areas were Photoshopped over with the same colors, but adjusted to allow dimension and design lines to remain visible. Thus, each product had the intended colors visible in most of the product space.

Product Winnowing. The number of product-stimuli was deemed too great for the scope of this study. It was necessary to winnow the large set to a more reasonable number of products, given the number of colors and domains to be tested. One consideration in the winnowing process was the complexity of the stimuli imagery (e.g. shading, texture, style lines, clarity, size) in regard to the new Photoshopping method. For example, the VR headwear had curved lines, reflective material, and small details that made it the most complex and arduous product to Photoshop to maintain color accuracy and product texture. Consequently, it was not included in the second iteration. The other consideration was on the results of the pilot test. A product that displayed implications of possible color effect was desired for further study and confirmation, while one which had seemingly no or little variation in color was also pursued for comparative purposes. After considering Photoshopping simplicity and study results, the activity monitor was selected as the product with little/no color effect, and two products, the smart glasses and headband were selected as products with observed color differences. The latter two were also selected for their differences in assumed recognizability: smart glasses are far more frequently mentioned in the literature and news than are asymmetrical headbands, which could influence assumed or known function. One point to make, however, is that while the shading and design details were able to be maintained in the activity monitor, the very fine texture on the band of the monitor was not able to be maintained in the new Photoshopping process. **See Appendix E.**

Participant Recruitment. In the next iteration of the study, larger sample sizes were desired: approximately 130 to 150 participants per product evaluation. Although sample size requirements vary based on study needs, 100 participants are generally the requisite minimum for survey based research when looking to obtain statistical confidence, and more than 30 individuals are needed to meet the assumptions of standard statistical tests used for comparing groups to ensure reliability ("Survey Statistical Confidence," n.d.).

Further, age of recruited individuals was confined to one generation. As color associations are frequently determined by the interplay of culture and time, color evaluations may also differ between different age groups. There is evidence showing, for instance, differences in color preferences between age groups (Beke et al., 2008.; Dittmar, 2001; Hurlbert & Ling, 2012; Ou, Luo, Sun, Hu, & Chen, 2012). Additionally, color evaluations may differ between generations due to the degradation of vision that is known to accompany aging (Hazare, Yang, Chavan, Menon, & Chougule, 2016; Salvi, Akhtar, & Currie, 2006). In the pilot, the majority of participants were under the age of 38, and there were very few participants ($\bar{x}$=7 per sample) older than 37—thus statistically analyzing for rating differences as reason for exclusion was not feasible. Still, to limit possible age effects and to strengthen sample characteristics, age was restricted to the millennial generation: ages 21 to 37 in 2018 (Dimock, 2019). Gender was also limited to males and females.

For worker qualifications, all Mechanical Turk participants that completed previous HITs were excluded from taking the new survey. Additionally, because more participants were needed for this survey, all workers who had >98 HITS approved (vs the 100 HITS threshold in the pilot) were allowed to take the survey.

Color Blindness. A web-based version of the color blindness test was explored when creating the final survey for this study as a possible option to control for color blindness. The most common test for color vision deficiency is the Ishihara Colour Vision Test: a test that consists of 38 plates of colored numbers and lines to be identified. Web-based versions of the test exist; however, the test is traditionally conducted in person. The official Ishihara website explicitly states that "Imitation tests and online tests have no scientific basis and are not reliable, resulting in a high rate of false positives and/ or false negatives," ("Ishihara Colour Test," n.d.) and recommends against such tests. Yet, some studies have found statistically similar results for computer-based tests as compared to the paper tests (Marey, Semary, & Mandour, 2015). However, the computer models and display settings were kept constant (Marcy et al., 2015). Conversely, another study compared two smartphone applications (using a controlled phone/interface) to the paper Ishihara test, and found one smartphone app to be comparable to the booklet-based test and one app to be significantly different (Sorkin et. al, 2016).

Still, a web-based version of the color blindness test was explored as a possible option to control for color blindness. As a digital copy of the Ishihara Colour Test was not accessible to implement directly, a pre-existing web-based version of the test was utilized, per suggestion of a University of Minnesota Optometrist. A pilot survey was designed using the web-based Colblindor Ishihara Colour Test[3], which uses digital scans of the traditional plates. An online survey was created using Qualtrics Survey Software, and directions were provided for accessing the Colblindor Ishihara Colour Test online and for

[3] https://www.color-blindness.com/ishihara-38-plates-cvd-test/

uploading the test results (i.e. entering a site produced results URL) in the Qualtrics survey. Results from the Colblindor site are completely anonymous and only indicate whether the test was taken and whether color blindness had been detected. The pilot was set up only to determine the feasibility of including this method in the final survey as a filtering process.

Following the Colblindor test, pilot test questions asked how easy the survey directions were to follow and how easy the test results were to upload. The survey was listed on Mechanical Turk and the assignment was completed by 17 people. Almost all participants (n=15, 88%) selected Yes, that the survey directions were easy, but in the feedback, some (n=5, 29%) found the Ishihara test or uploading process confusing. One individual also failed to properly upload their results.

The color blindness test itself was estimated to take approximately 2 minutes to complete, but with the addition of website access directions, possible complications or confusion, and the uploading process etc., the time to complete more than tripled timing estimates ($\bar{x}$=7 minutes and 37 seconds). The survey was timed from the opening of directions up to the uploading of results, and prior to feedback questions. For some, the time was more than double the average.

Given the complexity, the questionable testing accuracy using a non-traditional test, and the extensive timing this method would require (which would drastically increase costs), this method was deemed inadequate for pursuing any further. Instead, it was decided to rely on self-reported color blindness to filter out individuals with color vision problems. The following questions were added in the final survey: "To the best of your knowledge, are you color blind?" and "Have you been tested for color blindness before?." Participants were informed that their responses would not affect their submission on Mechanical Turk, and all participants were paid for their time regardless of response. Only data from those who reported that they were *not* colorblind (regardless of whether they had or had not been tested) were kept for analysis.

Survey Design and Questions. Each survey introduction began with instructions asking participants to adjust their monitor to its best visibility settings. Next, as in the pilot study, every participant was presented with one of each product (activity monitor, smart glasses, and headband), each in a randomly selected color and in a random order. After each product image were two questions. One was the same multiple-choice question as in the pilot study, which asked participants to select all “most likely” areas that the product belongs to. Answers were similarly presented in a random order. Added to the survey was a secondary question asking participants to select only one area from their previous responses that was the “most likely” or “most dominant” assumed answer. In addition, after re-reviewing the literature and common product domains, one more domain was added to the list of options—that of Communication. At the end of the survey were the demographic questions, and the two questions asking about color blindness. One attention check question was included in the survey. The new survey paid $0.35 a HIT after estimating the new task time length. **See Table 16 and Appendix F.**

Table 16. Final Survey Product Domains

Domain	Description
Communication	used to share or receive information
Fashion	used for aesthetic purposes
Gaming & Entertainment	used for recreational and entertainment purposes
Health & Wellness	used by an everyday person to promote their health
Industry	used by someone to perform their job, usually in the production of goods or services
Lifestyle	used for general, day-to-day tasks
Medical	used by doctors or patients for medical reasons
Military	used by military personnel for the purposes of training or combat
Security/Safety	used for protection
Sports & Fitness	used to assist in the performance of athletic activities
Other	please describe

Qualitative question additions. A secondary version of the survey was created with additional questions to probe for more in-depth explanations of the domain selections. To offset the increased cost and time of a longer survey, only a subset of the new participants (~50 individuals per product) took this version. In this version, after each product was displayed and domain questions asked, two open-ended questions were added: “In your opinion, what would you assume the product is and does?” and “Is the product something that is recognizable?” At the end of the survey, in the demographic section, one open-ended question and one multiple choice question were added: “Is the term ‘wearable technology' recognizable?" and "Before taking this survey, would you have categorized any of the products you saw as a 'wearable technology' product?" These last two questions were included at the end of the survey to avoid influencing how participants answered the previous questions and were included to see what information and knowledge participants might have and be referencing to inform their product domain assumptions. An attention check was not included in this survey, as open-ended responses already required attention to be properly addressed. Surveys with these additional questions paid $0.80 a HIT. **See Appendix G.**

Methods of Analysis. In the pilot study, randomization tests to find a difference in proportion were used to test for differences in domain count selection within a single product. These tests are time consuming and require great computational power, but they are useful for analyzing small sample sizes that do not meet the assumptions of traditional tests. However, in the final survey, larger sample sizes were recruited, and more traditional statistical tests were possible and therefore utilized.

Multiple choice and paired sample t-tests. For the multiple-choice domain selection questions (e.g. Medical vs Fashion, etc.) for each product, paired sample t-tests were used to compare selection count for each domain (categorical variables were first converted into binary ordinal numbers, 0=no selection and 1=a selection). Paired t-tests, rather than two-sample (unpaired) tests, were used because each domain choice was selected/not selected by the same participant sample for that product. Additionally, *every* domain count was compared against every other domain count, rather than only against the most selected domain; this was done to avoid excluding other highly selected choices. With 11 domain options, 10 colors, and 3 products, this equaled 1,650 comparisons. Due to the immense increase in statistical tests used in this next survey iteration—which increases the likelihood of a Type I error (false positives occurring)—a Bonferroni Correction was applied to decrease the level at which significance would be measured, thereby decreasing the chance of a false positive. For 1,650 comparisons, the Bonferroni Correction was calculated and set the new level of significance at $p<0.00003$. **See Appendix H.**

Domain comparison between colors and two-sample t-tests. In the pilot study there were many instances where the same Top Domains were selected regardless of the product's color (e.g. Health & Wellness in blue and in green, etc.). Yet, sometimes large differences in count size were observed despite the same domain occurrence in each color. Thus, in the final study, the selection counts for all Top Domains were compared across all color versions of the product (e.g. Communication in blue vs Communication in black, etc.). For this comparison, two-sample t-tests assuming unequal variance were used. Two-sample t-tests were selected because each product-color was viewed/rated by a unique (independent) participant sample. T-tests were only run on Top Domains and not on low count non-Top domains. After finding the Top Domains in the results for all products, the researcher determined the number of new comparisons to run (n=675). The Bonferroni Correction was again applied. Based on 675 comparisons conducted with the two-sample t-tests, the level of significance was lower to $p<0.00007$. **See Appendix I.**

Calculating product Top Domains. Given the new statistical tests run between all domain selections, new rules were created for determining what constituted a Top Domain. Top Domain Level determination rules are relative and based on each domains' comparative relationship between all subsequent domains. Size of selection count is then also considered, and each level has an additional selection-count allowance/exception. All Top Domain Levels had a cut-off selection size allowance of 30% of the viewing participant sample. This threshold was selected to account for any sizeable domain agreement between participants (several Top Domains in the pilot had a similar count size), while also allowing for a reasonable and practical limit on the amount of statistical differences that would be considered when comparing lower count domains. Exceptions on this limit were made for any <30% domain that was not significantly different from a ≥40% domain). **See Table 17.**

Table 17. New Survey Top Domain Rules

Top Domain Levels	**Determination Rules**
High Level (HL)	domains that are not significantly different from the most selected domain
Mid Level (ML)	domains that are not significantly different from at least one High Level domain but are significantly different from the number one most selected domain OR domains that have a ≥40% selection count and are significantly different from all High Level domains.

Low Level (LL)	domains that are not significantly different from at least one Mid Level domain but are significantly different from all High Level domains OR =domains that have a ≥30% selection count and are significantly different from all High Level and Mid Level domains.
Exception (E)	domains with a <30% selection rate that are not significantly different from a ≥40% Top Domain

Single choice and frequency. For the single domain choice (most likely choice from the multiple domains selected) question for the same product, only descriptive statistics (frequency) were used to report selection counts. Paired sample t-tests were not appropriate for the selection comparisons, due to the dependency of each selection on all available selections (e.g. choosing one domain meant not choosing any others), and two-sample t-tests were not appropriate because the participant samples selecting/not selecting domains within a single product were not independent. Therefore, only selection count was analyzed.

Qualitative questions. Answers to the open-ended and recognition questions for every color of a single product were combined into a single list (for each product). Total replies including all products and all colors, on both the device's assumed function and the device's recognizability, equaled 3,132 descriptive responses. Due to the size and scope of the data, a rigorous method of analysis was not used on the open-ended responses for this study. Instead, the results for all colors in a single product were combined and briefly summarized to support the quantitative data. Word clouds were generated to summarize responses on what the product was, and word clouds were generated to summarize the responses on whether the product was recognizable and why. Common words, such as "the," "or," and "and," etc., were filtered from the summaries. The size variance in the word cloud words is relative to the frequency differences between the words in the actual response summaries. A variety of quotes were also pulled to complement the word cloud findings. For any categorical questions, the frequency was calculated and reported.

Domain selection combination frequency. Another measure added to the final data analysis was the determination of domain selection combinations (i.e. domains which were selected together most frequently in the multiple-choice question). First, all possible unique combinations were calculated. Given a sample set of 11 domains, with combination selection possibilities ranging from two domains to all 11 domains, the total number of possible unique combinations equaled 2,047 unique domain strings. After creating a list of all possible strings, all domain combination selections present in the data were collected (i.e. matched to possible strings), and then frequency was calculated and recorded.

Chapter IV

Final Results

The second iteration of the study showed some similar and some quite different results in color-domain selections compared to the pilot test. Presented below are the color and domain-selection findings for the revised product-colors. A summary chart for all product domain selections is presented for the products, as one was for the pilot. Results for the additional survey questions then follow.

Final Survey Sample Demographics

In the final study, data from 1,413 Mechanical Turk workers who self-reported as non-colorblind were recorded and analyzed after excluding 185 submissions for attention check failures or unqualified work (e.g. submitting more than one survey). Qualtrics also reported an attrition rate of approximately 300 individuals—which may have been in part because the survey was not designed for mobile phones, and mobile phones are a popular input device for online survey taking (Bosnjak, Bauer, & Weyandt, 2018). Additionally, approximately 40% of workers reported that they had been tested for color blindness and 53 individuals reported that they were colorblind; submissions from the 53 individuals were also excluded.

Limited to the millennial age bracket (21 to 37), the average age recorded across all 1,413 participants was 30 years old (sd=4.55). Between genders, the sample was comparably divided between males (48%) and females (52%). Participants also largely identified as White (74%), then Asian (10%), Black or African American (9%), American Indian or Alaskan (2%), and Native Hawaiian or Pacific Islander (1%); 9% were Hispanic and 3% Latino. 112 (8%) MTurkers, selected more than one race or ethnicity. Additionally, regarding self-reported color blindness, 39% of the 1,413 non-colorblind sample selected that they had been tested for color blindness before.

Individual sample sizes (viewing participants) for each product ranged from 131 to 151 MTurkers. Specific sample sizes are described in the results for each product. Of these, 44 to 59 MTurkers in each product's viewing sample, for a total 37% of the entire 1,413 MTurkers participants, also answered additional qualitative and open-ended questions about each product's assumed functions and about wearable technology.

Armband Activity Monitor

Almost identical results to the pilot test were observed in the revised colors for the activity monitor armband. In the pilot test, the Top Domains were S&F and H&W in all colors, while Medical was a Top Domain in red. In the second iteration, S&F, H&W, and Medical were the Top domain selections in all products, regardless of color, and Lifestyle was a Low Level Top Domain in some.

Multiple Selection and Top Domain Results. As discussed, the Top Domains (TD) were determined by comparing each domain to the most selected choice and then by also considering other highly selected domains (>30%) that might be significantly smaller in count than the most selected choice. S&F and H&W were the two most selected (High Level) domains in every color of the armband, and were statistically similar ($p>0.00003$) in every color. Strong product-domain associations for these two were seen in the activity monitor regardless of color. Across all colors, these two domains were each selected by nearly two-thirds (73%) or more of the viewing participants. These were the two most common, but not the only Top Domains.

In beige, H&W (80%), S&F (76%), and Medical (59%) were statistically similar in selection count ($p>0.00003$) and all High Level Top Domains. Beige was the only color in which Medical was a High Level domain. Notwithstanding, Medical was still selected by a significant majority in all other colors. In the remaining nine colors, Medical was a Mid Level Top Domain. In white, red, and green, Medical was selected significantly fewer times than H&W but not S&F. Medical was selected by a majority (≥58%) of participants in each of these colors. Additionally, in white, red, and green, Medical was selected significantly more times ($p<0.00003$) than all remaining subsequent count domains, which all had a selection count of <28%. In six colors (yellow, purple, pink, orange, blue, and black), Medical was selected significantly fewer times than both H&W and S&F, but still had a majority vote by participants (41 to 63%, $\bar{x}$=54%) across all colors. Further, Medical's slightly lower count made Lifestyle (selected at a statistically similar rate $p>0.00003$) a Low Level or Exception Level Top Domain in yellow, pink, orange, blue, black (31 to 38%), and in purple (22%). In yellow, orange, blue, and black, Lifestyle was selected significantly more times ($p<0.00003$) than all remaining subsequent count domains. Further, though Lifestyle was not considered for a Top Domain position in all colors (did not make the 30% threshold or was not statistically similar to a higher level domain)—trend-wise, it was consistently the fourth most selected domain across all colors. Participants widely saw the activity monitor as a S&F and H&W product, while most also saw it as a Medical product. Lifestyle was a common assumption but less dominant in the group. **See Table 18 and Appendix H.**

Table 18. Activity Monitor Top Domains

Color	**Top 1st**	**Top 2nd**	**Top 3rd**	**Top 4th**
Yellow	S&F **HL**	H&W **HL**	Medical **ML**	Lifestyle **LL**
n=145	84%	79%	50%	32%
White	H&W **HL**	S&F **HL**	Medical **ML**	
n=140	86%	81%	58%	
Purple	H&W **HL**	S&F **HL**	Medical **ML**	Lifestyle **E**
n=142	83%	73%	46%	22%
Red	H&W **HL**	S&F **HL**	Medical **ML**	
n=140	87%	79%	63%	
Pink	H&W **HL**	S&F **HL**	Medical **ML**	Lifestyle **LL**
n=131	86%	81%	54%	31%
Orange	H&W **HL**	S&F **HL**	Medical **ML**	Lifestyle **LL**
n=143	78%	76%	41%	38%
Green	H&W **HL**	S&F **HL**	Medical **ML**	
n=133	84%	78%	59%	
Blue	H&W **HL**	S&F **HL**	Medical **ML**	Lifestyle **LL**
n=137	89%	83%	56%	33%
Black	S&F **HL**	H&W **HL**	Medical **ML**	Lifestyle **LL**
n=138	86%	78%	49%	31%
Beige	H&W **HL**	S&F **HL**	Medical **HL**	
n=145	80%	76%	59%	

Top Domain Comparisons Across Colors. Combining all activity monitor colors, the total Top Domains selected by participants were Medical, H&W, S&F, and Lifestyle. Two-sample t-tests assuming Unequal Variance and the Bonferroni Correction were used to determine how each Top Domain selection rate compared between colors (e.g. H&W in yellow vs. H&W in black). The aim was to see if one color might elicit more participant agreement (and hence an assumedly stronger or weaker association) between an individual Top Domain and color.

Despite the range in sample selection counts across colors (see Table 18 above), the tests did not find any significant differences in any color comparisons. Although many low p-values were discovered in the color to color comparisons, no color to color comparison for any of the Top Domains was determined to have a difference of $p<0.00007$. Thus, that color might strengthen or weaken a single product-domain association was not supported in the activity monitor. **See Appendix I.**

Single Selection Results. After allowing multiple selections in the domain assessment, participants were then asked to select only one domain that they believed to be most associated with the product under review. Single selection answers were similar to the results from the multiple-selection question, but slight differences were observed. Per reasons described in the Methods, significance in selection count was not analyzed for these results.

In all colors, H&W and S&F were again the two most selected domains for the activity monitor; however, unlike in the multiple-choice question where H&W was the most selected domain in most colors (though not significantly different from the S&F domain), in the single-choice question S&F was the prevailing choice and often at a greater rate than the H&W selections. Additionally, the selection count was also decreased for each domain, given that the participants had to decide on only one option in the single choice question. For instance, the largest selection count for S&F in the single-option question was 61% of the sample (in black), compared to the previous 86% count when multiple selections were allowed.

Medical was not selected by a majority (5 to 14%) in any color of the activity monitor product. Despite its low count rate, an important detail to call out is that out of all colors, the largest selection count (14%) for the Medical domain selection was in the color beige. Though the count is small, the trend is noteworthy, nonetheless. All other domains, including Lifestyle, were selected by 2% or less of the viewing participants for all colors. The product is mainly associated with S&F or H&W. **See Table 19.**

Table 19. Activity Monitor Single Selection Frequency

Color	Medic	H&W	Milit	Secur	G&E	S&F	Fash	Life	Comm
Yellow n=145	6%	33%	0%	1%	1%	57%	1%	1%	0%
White n=140	11%	34%	0%	0%	1%	54%	0%	1%	0%
Purple n=142	12%	38%	1%	1%	1%	47%	0%	1%	0%
Red n=140	9%	39%	0%	0%	1%	51%	0%	1%	0%
Pink n=131	5%	44%	0%	1%	1%	48%	0%	1%	0%
Orange n=143	8%	41%	1%	1%	1%	48%	0%	1%	0%
Green n=133	8%	34%	0%	0%	2%	56%	0%	1%	0%
Blue n=137	8%	34%	0%	1%	0%	57%	0%	0%	0%
Black n=138	10%	25%	0%	1%	1%	61%	0%	1%	1%
Beige n=145	14%	34%	0%	1%	1%	48%	0%	2%	0%

*Domains with 0% selection in all colors are not displayed

Smart Glasses

In the pilot test, the Top Domains for the smart glasses ranged from G&E, Industry, Military, and Medical for most colors; and Lifestyle and Security for some colors. With the additional of Top Domain levels, in the second iteration, the domain selections included G&E, Industry, Military, and Medical in all colors; Lifestyle in all colors except yellow; and Security in one color (red, which differed from the pilot test, in which it was observed in yellow). Further, Communication, the added domain, was a Top Domain in all colors in this iteration.

Multiple Selection and Top Domain Results. G&E was a High Level Top Domain in every color, and the most selected domain, ranging from a 55 to 64% ($\bar{x}$=60%)

selection rate, in every color except beige (Medical was the most selected domain in beige) and blue (G&E and Industry were selected an equal number of times). Multiple other Top Domains were present across colors. G&E, Industry, Medical, Military, and Communication were Top Domains in every color; Lifestyle was a Top Domain in every color, except in yellow. Yet, the selection order and the Top Domain Level of these five varied from color to color.

In pink, G&E was selected (63%) significantly more times ($p<0.00003$) than all other choices and was the only High Level domain. The following order of domain orders were observed: Communication (Mid Level TD); Industry, Lifestyle, Medical (Low Level TD); and Military (Exception Level). In purple, red, and orange, G&E, Medical, and Industry were High Level TDs selected at a statistically similar rate ($p>0.00003$). Communication, Military, and Lifestyle were all Mid or Exception Level Top Domains in these colors. In addition, in the color red only, Security was also an Exception Level Top Domain seen in the glasses. See Table 20 for selection counts of each domain for these three colors. Other colors in which G&E, Medical, and Industry were High Level TDs were green, blue, yellow, and beige. However, in these colors, Communication was also a High Level Top Domain—signifying a potentially stronger group association. Similarly, in the yellow and beige glasses, Military was also a High Level Top Domain. In green and blue, however, Military and Lifestyle were both Mid Level or Exception Top Domains. In beige Lifestyle was an Exception Level Top Domain, and in yellow, Lifestyle was not a Top Domain on any level.

Finally, in the colors black and white, we see the same six Top Domains observed in the previous colors, but again with differences between the calculated levels. In black and in white, Industry was *not* a Hight Level TD as in the other colors. In each, it was a Mid Level Top Domain. And in white, Medical was not a High Level Top Domain, but a Mid Level domain. In black and white Military and Lifestyle were either a Mid Level Top Domain or Exception Level Top Domain, which was similar to other colors.

Certain information above is worth highlighting. Military was an Exception Level (<30%) Top Domain in white, purple, and pink. Lifestyle was an Exception Level (<30%) Top Domain in red, orange, green, black, and beige—and was not a Top Domain contender at all in yellow. These were the least common, of the Top Domains, domain associations.

The smart glasses were generally seen as a G&E, Medical, Industry, or Communication device. Military and Lifestyle were just as likely to be perceived in any given color, but generally less dominantly compared to the other TDs. Regardless of Top Domain Levels, the only color in which a unique domain was observed in the smart glasses was with the color red. In red, the domain Security was a lower level domain but statistically similar in selection count to most larger count TDs. The color red plausibly elicited some association to Security. Further, a unique observation was found in the beige glasses. In the beige color, Medical was the most selected domain. This is the only color in which G&E was not the most selected domain. However, although interesting, as stated in the previous paragraph, the selection counts for these two domains were not significantly different.

Finally, although there is a majority participant selection count on multiple domains in every color, there is less consensus on any single domain than was observed in either of the other two products under study. In the activity monitor, in at least one color, there was a domain selected by 86% of the viewing participants. In the headband, presented in the next section, in at least one color, there was a selection by 85% of the participants. However, for the smart glasses, the highest domain agreement was by 64% of the sample (G&E in white). **See Table 20 and Appendix H.**

Table 20. Smart Glasses Top Domains

Color	Top 1st	Top 2nd	Top 3rd	Top 4th	Top 5th	Top 6th	Top 7th
Yellow	G&E **HL**	Industry **HL**	Medical **HL**	Military **HL**	Comm **HL**		
n=135	55%	51%	39%	36%	33%		
White	G&E **HL**	Comm **HL**	Lifestyle **ML**	Industry **ML**	Medical **ML**	Military **E**	
n=142	64%	45%	37%	35%	34%	25%	
Purple	G&E **HL**	Medical **HL**	Industry **HL**	Comm **ML**	Lifestyle **ML**	Military **E***	
n=145	60%	39%	37%	37%	30%	23%	
Red	G&E **HL**	Industry **HL**	Medical **HL**	Comm **ML**	Military **ML**	Security **E**	Lifestyle **E**
n=141	63%	51%	42%	37%	33%	26%	23%
Pink	G&E **HL**	Comm **ML**	Industry **LL**	Lifestyle **LL**	Medical **LL**	Military **E**	
n=137	63%	41%	36%	36%	33%	23%	
Orange	G&E **HL**	Industry **HL**	Medical **HL**	Comm **ML**	Military **ML**	Lifestyle **E**	
n=142	62%	44%	42%	41%	33%	27%	
Green	G&E **HL**	Industry **HL**	Medical **HL**	Comm **HL**	Military **ML**	Lifestyle **E**	
n=145	61%	50%	48%	46%	30%	26%	
Blue	G&E **HL**	Industry **HL**	Medical **HL**	Comm **HL**	Lifestyle **ML**	Military **ML**	
n=141	55%	55%	49%	44%	31%	31%	
Black	G&E **HL**	Medical **HL**	Comm **HL**	Industry **ML**	Military **ML**	Lifestyle **E**	
n=139	60%	45%	45%	40%	35%	28%	
Beige	Medical **HL**	G&E **HL**	Industry **HL**	Comm **HL**	Military **HL**	Lifestyle **E**	
n=139	55%	53%	50%	35%	33%	26%	

*Exception to the Exception Level: pulled by a <40% domain (39% HL domain)

Top Domain Comparisons Across Colors. After grouping all colors together, the total Top Domains that were selected in the smart glasses product were the domains Communication, G&E, Industry, Lifestyle, Medical, Military, and Security. Again, though all were Top Domains in most colors, counts across colors for any individual domain were wide ranging. Thus, two-sample t-tests assuming Unequal Variance and a Bonferroni Correction were run in a color to color comparison (e.g. S&F in red vs S&F in yellow, etc.) to determine whether more participant sample agreement was observed for a single Top Domain in certain colors. Differences were expected due to the range of selection counts (e.g. 55% Medical in beige vs. 33% Medical in pink) seen across colors (see Table 20 above).

Two-sample t-tests were run for each Top Domain and compared between every color. Again, the color to color comparison of each domain resulted in very low p-values. However, again, significant difference ($p<0.00007$) between any two colors for any single Top Domain was not seen in the analyses. The tests did not find support for the assumption that color might strengthen or weaken a single product-domain association in the smart glasses. **See Appendix I.**

Single Selection Results. When limited to only one domain selection, results for the smart glasses became even less concise in participant selection count. There was no color in which a domain was selected by even half of the viewing participants. In most colors, less than 30% of participants selected any single domain choice. Additionally, once limited to only one domain selection, G&E was no longer the most selected domain in every color. In yellow and blue, Industry was the most selected domain (25% in each), and in black and beige, Medical was the most selected domain (24% and 27%, respectively). In the multiple selection results, significant differences between those domains (G&E, Industry, and Medical) were not observed and so it is reasonable for a mix of the High Level Top Domains to be the most selected domain in the single choice response. The trend lines of most selected to least selected Top Domains in the single choice responses closely mimics the results from the multiple-choice responses; however, the low counts indicate that, of the many Top Domains, there is no dominating single group-perceived domain association. **See Table 21**.

Table 21. Smart Glasses Single Selection Frequency

Color	Indus	Medic	H&W	Milit	Secur	G&E	S&F	Fash	Life	Comm	Other
Yellow n=135	25%	20%	2%	7%	1%	22%	0%	1%	3%	16%	1%
White n=142	11%	13%	1%	9%	1%	29%	1%	0%	15%	18%	1%
Purple n=145	19%	20%	1%	4%	2%	32%	1%	1%	10%	11%	1%
Red n=141	23%	16%	0%	5%	7%	29%	0%	1%	7%	11%	1%
Pink n=137	18%	11%	2%	4%	2%	34%	1%	1%	15%	11%	1%
Orange n=142	18%	16%	2%	6%	4%	32%	1%	1%	8%	13%	0%
Green n=145	18%	19%	1%	6%	1%	28%	0%	1%	10%	16%	1%
Blue n=141	25%	20%	1%	5%	4%	18%	0%	0%	10%	16%	1%
Black n=139	17%	24%	3%	6%	1%	23%	1%	0%	9%	17%	0%
Beige n=139	19%	27%	3%	10%	1%	17%	0%	0%	9%	12%	2%

Neurostimulation Headband

The two most selected domains for the headband (Medical and H&W) mirrored the results observed in the pilot test; however, most of the other Top Domains from the pilot test results were not Top Domains in the revised study. In the pilot version, the headband's Top Domains were Medical in all colors, H&W in most colors, and Lifestyle, G&E, Industry, and Military in only a select few colors. In the revised colors, Medical and H&W were Top Domains in every headband, while G&E, S&F, and Communication were Top Domains in only one or two colors.

Multiple Selection and Top Domain Results. In every color, Medical was the most selected High Level domain, and selected by a large majority (64 to 85%, $\bar{x}$=77%) of each viewing participant sample. H&W was the second most selected domain in every color, and selected by ≥47% of the viewing participants for every color ($\bar{x}$=55%). H&W was a High Level Top Domain in seven colors: yellow, white, purple, pink, orange, green, and beige. It was a Mid Level Top Domain, selected significantly fewer times ($p<0.00003$) than Medical, in three colors: red, blue, and black. Given these results and that each was selected by more than, or very near to half of every participant sample, Medical and H&W are clearly assumed product domains, regardless of the color of the device. Other domains were selected at significant rates, however.

In green, G&E, and Communication were Mid Level Top Domains. In this color, H&W was selected by slightly less than half (48%) of the sample, and pulled G&E (31%) and Communication (30%) to a Mid Level rank. In blue, H&W (47%), was a Mid Level TD (selected significantly fewer times than Medical) and was selected significantly more times than all remaining domains, except Communication—which 28% of the participants had selected, making Communication an Exception Level Top Domain.

In the color pink, Medical and H&W (High Level TDs) were selected significantly more times than all other domains, but S&F was also selected by more than 30% of the viewing sample (31%). Thus, S&F is counted as a Low Level Top Domain in the color pink.

Lastly, though most of these sub level Top Domains did not exceed a 30% selection count in other colors, it is worth noting that the trends in selection order were fairly consistent in all colors. Ultimately, however, Medical and H&W were the predominant product domains regardless of color, and the only Top Domains in most. **See Table 22 and Appendix H**.

Table 22. Headband Top Domains

Color	Top 1st	Top 2nd	Top 3rd	Top 4th
Yellow	Medical **HL**	H&W **HL**		
n=143	76%	54%		
White	Medical **HL**	H&W **HL**		
n=142	82%	60%		
Purple	Medical **HL**	H&W **HL**		
n=131	77%	56%		
Red	Medical **HL**	H&W **ML**		
n=141	80%	55%		
Pink	Medical **HL**	H&W **HL**	S&F **LL**	
n=144	79%	60%	31%	
Orange	Medical **HL**	H&W **HL**		
n=143	73%	53%		
Green	Medical **HL**	H&W **HL**	G&E **ML**	Comm **ML**
n=135	64%	48%	31%	30%
Blue	Medical **HL**	H&W **ML**	Comm **E**	
n=150	76%	47%	28%	
Black	Medical **HL**	H&W **ML**		
n=131	75%	50%		
Beige	Medical **HL**	H&W **HL**		
n=136	85%	64%		

Top Domain Comparisons Across Colors. The total Top Domains that appeared in different color versions of the headband were Medical, H&W, G&E, S&F, and Communication. Two-sample t-tests assuming Unequal Variance and the Bonferroni Correction were run to compare the color to color selection rates for these domains (H&W in black vs H&W in orange, etc.) to determine whether the different rates (assumed varying strength of association) of participant selection in certain colors were significantly different.

Just as was observed in the armband and the smart glasses, fairly low p-values were discovered in the color to color comparisons of the headband Top Domains, but none were significantly different ($p<0.00007$) in selection rate. The test results did not find any support for the hypothesis that color strengthened or weakened an individual product-domain association. **See Appendix I**.

Single Selection Results. Participants were asked to select a single domain from the multiple domains selected prior. When asked to select only one domain related to the product, Medical took the majority vote (47 to 65%, $\bar{x}$=57%) in every color, far exceeding the remaining domains, including even H&W—the second most selected single choice in every color (11 to 20%, $\bar{x}$=17%). Regarding the trendline of the remaining domains, Communication was the next most selected option in the single-choice question in almost every color, though to a much smaller degree (4 to 15%, $\bar{x}$=9%) than Medical. The single select question shows the prevailing assumed function of Medical for the headband. **See Table 23**.

Table 23. Headband Single Selection Frequency

Color	Indus	Medic	H&W	Milit	Sec	G&E	S&F	Fash	Life	Comm	Other
Yellow n=143	1%	58%	20%	0%	0%	6%	5%	0%	0%	10%	0%
White n=142	0%	65%	18%	0%	2%	1%	4%	1%	1%	7%	0%
Purple n=131	2%	56%	12%	3%	2%	5%	5%	2%	2%	10%	0%
Red n=141	2%	56%	20%	2%	2%	5%	1%	4%	2%	6%	0%
Pink n=144	0%	63%	19%	1%	0%	6%	3%	1%	3%	4%	0%
Orange n=143	1%	59%	17%	3%	2%	4%	1%	1%	2%	8%	0%
Green n=135	3%	47%	16%	1%	2%	10%	2%	2%	1%	15%	0%
Blue n=150	0%	52%	17%	3%	1%	4%	5%	0%	6%	13%	0%
Black n=131	2%	53%	11%	3%	2%	8%	5%	5%	1%	8%	1%
Beige n=136	2%	64%	18%	0%	0%	0%	3%	1%	3%	10%	0%

Activity Monitor, Smart Glasses, and Headband Domain Selection Summary

To summarize the selection summaries, a product domain chart was created. The results of the second iteration findings are presented below. Given that Top Domain results from the revised survey were frequently similar to pilot results findings, the pilot results for the products that did not get included in the second iteration are included as well, for product and location comparison purposes. Pilot limitations should be kept in mind. The pilot results are displayed in gray.

Across all products and all colors in the second version products, Medical was a Top Domain. For the arm worn products, Medical, H&W, and S&F were still common in all, and in the final version activity monitor they were Top Domains in all colors. There is also a common finding of Lifestyle between the activity monitor and the gesture band, both of which are armband products.

In the head worn products, of which two out of three were second iteration results, there were again common findings of Medical, and G&E in all products, though in only one color in the headband. Industry, Military, and Security similarities were also still observed in the eyewear products. Further, with the addition of Communication in the second iteration survey we see a common domain result in the two head worn products. This selection cannot be determined for the pilot-only products, as it was not a possible domain response. **See Table 24**.

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Table 24. Domain Selection Results Summary

Location		Product	Lifes	G&E	Indust	Milit	Sec	Med	S&F	H&W	Fash	Comm
arm location	arm band	**activity monitor**	+all LL - white - red - green - beige	x	x	x	x	+all M	+all H	+all H	x	x
arm location	arm band	**gesture band *pilot results**	+grey	x	x	x	x	+orange +white +grey	+all	+all	+all -green -pink	n/a
arm location	full arm	**exo arm support *pilot results**	x	x	x	+grey	x	+all	+black +red +beige	+pink +red +beige +grey	x	n/a
head location	eyewear	**smart glasses**	+all M/L -yellow	+all H	+all H/M	+all H/M/L	+red LL	+all H/M	x	x	x	+all H/M
head location	eyewear	**ar headset *pilot results**	x	+all	+all -white -beige	+all -white -green -blue -grey -purple	+blue +purple +pink +black +red	+grey +black	+red	x	x	n/a
head location	forehead	**headband**	x	+green ML	x	x	x	+all HL	+ pink LL	+all HL	x	+ green ML + blue E

"+"=observed only in this color; "-" =observed in all colors except this color; "n/a"=domain was not an option

Domain Combination Selection Frequency

Some questions that arose over the course of this study were whether certain domains occurred (i.e. were selected) together more frequently than others and whether there was a trend across products. Calculating the rate with which domains were selected in combination with one another was done to more fully understand the domain selections. This analysis was done only for the second iteration products (activity monitor, smart glasses, and headband).

All possible unique combinations were calculated and the total number of combinations possible when given a sample set of 11 (the number of domain options) and a sample selection of anywhere from one to all 11 options, equals a list of 2,047 possible unique combinations that might have been selected for each product-color. However, the actual list of unique combinations that was recorded for each product-color did not exceed 78 unique combination strings.

Unsurprisingly—given the consistency that was observed in the Top Domains in every product—the number of unique combinations that was observed did not differ drastically in frequency across colors in each product. In the activity monitor, 30 to 46 ($\bar{x}$=40) unique combinations were observed across colors; in the smart glasses 65 to 78 ($\bar{x}$=72) were observed; and in the headband 46 to 66 ($\bar{x}$=58) were observed. The number of domains in a combination string ranged from 1 to 10; no one selected all 11 domains in any product-color. The most common number of domains observed in a single combination string was 3 domains.

To that extent, a majority of the resulting unique combination strings were selected by very few participants. A range of 60 to 80% of the unique combination strings in any given color of the activity monitor were selected by ≤2 individuals; likewise, 75 to 86% of the unique combinations in all of the smart glasses and 78 to 92% of the unique combinations in all headbands were selected by ≤2 people. Even for the most common domain combination strings in each product, counts were very low. Presented below are all unique combinations with >10% selection (13 to 15 people), or fewer if there were no combination strings with >10% selections for a specific product-color. **See Tables 25-27.**

Table 25. Smart Glasses Unique Combos

Color	Combination String			Count
Yellow	Comm,	G&E		7%
Yellow	Indus,	Medic		7%
White	Comm,	G&E,	Life	8%
Red	Comm,	G&E		6%
Purple	Indus,	Medic		9%
Pink	Comm,	G&E,	Life	8%
Orange	Comm,	G&E,	Life	6%
Green	Comm,	G&E,	Life	7%
Green	Indus,	Medic		7%
Blue	Indus,	Medic		8%
Black	Comm,	G&E		6%
Beige	Indus,	Medic		9%

Table 26. Headband Unique Combos

Color	Combination String			Count
Yellow	H&W,	Medic		19%
White	H&W,	Medic		19%
White	H&W,	Medic,	S&F	13%
Red	H&W,	Medic		21%
Purple	H&W,	Medic		24%
Pink	H&W,	Medic		18%
Pink	H&W,	Medic,	S&F	13%
Orange	H&W,	Medic		17%
Green	H&W,	Medic		18%
Blue	H&W,	Medic		14%
Black	H&W,	Medic		19%
Beige	H&W,	Medic		29%

Table 27. Activity Monitor Unique Combos

Color	Combination String				Count
Yellow	H&W,	S&F			18%
Yellow	H&W,	Medic,	S&F		14%
White	H&W,	Medic,	S&F		24%
White	H&W,	S&F			19%
Red	H&W,	Medic,	S&F		19%
Red	H&W,	S&F			18%
Red	H&W,	Medic			11%
Purple	H&W,	Medic,	S&F		18%
Purple	H&W,	S&F			17%
Pink	H&W,	Medic,	S&F		21%
Pink	H&W,	S&F			17%
Orange	H&W,	S&F			17%
Green	H&W,	Medic,	S&F		18%
Green	H&W,	S&F			12%
Green	H&W,	Life,	Medic,	S&F	11%
Blue	H&W,	Medic,	S&F		23%
Blue	H&W,	S&F			17%
Black	H&W,	Medic,	S&F		20%
Black	H&W,	S&F			17%
Beige	H&W,	Medic,	S&F		23%
Beige	H&W,	S&F			12%

As can be seen in Tables 25 through 27, the selection rate of unique combinations was repeatedly low compared to individual domain counts found in the multiple selection results. However, a selection count for a unique combination is not a completely accurate reflection of common combinations. For example, H&W and S&F may be a *unique* selected domain combination, but this combination also occurs in other longer combinations strings (e.g. string: H&W, S&F, and G&E). Therefore, the count of domain combinations across all subsequently larger combination strings were calculated to better realize combination frequency. Tables display only combinations selected by >10% of participants.

Activity Monitor. The top trends for the most selected domain combinations were seen repeated in all colors and mirrored the Top Domain selections. H&W and S&F were always the most frequent combination selection in every color. These were then followed by H&W and Medical and then S&F and Medical. H&W, S&F, and Medical were seen less frequently together than only two of the three variables. Those who selected H&W more frequently selected Medical than did those who selected S&F; or conversely, those who selected Medical more frequently selected H&W than S&F.

The domain Lifestyle (a lower count TD) was, expectedly, selected in combination with these three at a smaller rate. Interestingly, in every color, Lifestyle was more frequently selected in conjunction with S&F or H&W, or both together, before it was selected in conjunction with the Medical domain. So, although Lifestyle was typically pulled into a Top Domain position by Medical (as their selection counts were not often significantly different), the two were actually less likely to be selected together (were perhaps seen as less related) than were Lifestyle and either S&F or H&W. **See Table 28.**

Table 28a-j. Activity Monitor Domain Selection Combinations in Each Color

Table 28a. Activity Monitor Black

Combo String			Count
H&W,	S&F		69%
H&W,	Medic		42%
Medic,	S&F		38%
H&W,	Medic,	S&F	34%
H&W,	Life		27%
Life,	S&F		27%
H&W,	Life,	S&F	23%
Life,	Medic		12%
H&W,	Life,	Medic	11%

Table 28b. Activity Monitor Purple

Combo String			Count
H&W,	S&F		58%
H&W,	Medic		39%
Medic,	S&F		31%
H&W,	Medic,	S&F	28%
H&W,	Life		19%
Life,	S&F		17%
H&W,	Life,	S&F	15%

Table 28c. Activity Monitor Yellow

Combo String				Count
H&W,	S&F			65%
H&W,	Medic			42%
Medic,	S&F			40%
H&W,	Medic,	S&F		32%
Life,	S&F			28%
H&W,	Life			27%
H&W,	Life,	S&F		23%
Life,	Medic			17%
Life,	Medic,	S&F		15%
H&W,	Life,	Medic		14%
H&W,	Life,	Medic,	S&F	12%

Table 28d. Activity Monitor White

Combo String				Count
H&W,	S&F			71%
H&W,	Medic			52%
Medic,	S&F			46%
H&W,	Medic,	S&F		43%
Life,	S&F			24%
H&W,	Life			22%
H&W,	Life,	S&F		21%
Life,	Medic			14%
H&W,	Life,	Medic		14%
Life,	Medic,	S&F		14%
H&W,	Life,	Medic,	S&F	13%
G&E,	H&W			11%

Table 28e. Activity Monitor Red

Combo String				Count
H&W,	S&F			69%
H&W,	Medic			56%
Medic,	S&F			48%
H&W,	Medic,	S&F		42%
Life,	S&F			24%
H&W,	Life			22%
H&W,	Life,	S&F		21%
Life,	Medic			17%
Life,	Medic,	S&F		17%
H&W,	Life,	Medic		15%
H&W,	Life,	Medic,	S&F	15%

Table 28f. Activity Monitor Orange

Combo String				Count
H&W,	S&F			57%
H&W,	Medic			35%
Medic,	S&F			32%
H&W,	Life			31%
Life,	S&F			29%
H&W,	Medic,	S&F		27%
H&W,	Life,	S&F		22%
Life,	Medic			18%
H&W,	Life,	Medic		17%
Life,	Medic,	S&F		14%
H&W,	Life,	Medic,	S&F	13%
Comm	H&W			11%

Table 28g. Activity Monitor Green

Combo String				Count
H&W,	S&F			65%
H&W,	Medic			55%
Medic,	S&F			44%
H&W,	Medic,	S&F		41%
H&W,	Life			26%
Life,	S&F			23%
H&W,	Life,	S&F		22%
H&W,	Life,	Medic		16%
Life,	Medic			16%
H&W,	Life,	Medic,	S&F	13%
Life,	Medic,	S&F		13%

Table 28h. Activity Monitor Pink

Combo String				Count
H&W,	S&F			69%
H&W,	Medic			50%
Medic,	S&F			43%
H&W,	Medic,	S&F		40%
H&W,	Life			27%
Life,	S&F			25%
H&W,	Life,	S&F		23%
Life,	Medic			16%
H&W,	Life,	Medic		15%
H&W,	Life,	Medic,	S&F	13%
Life,	Medic,	S&F		13%

Table 28i. Activity Monitor Blue

Combo String				Count
H&W,	S&F			74%
H&W,	Medic			54%
Medic,	S&F			45%
H&W,	Medic,	S&F		45%
H&W,	Life			31%
Life,	S&F			28%
H&W,	Life,	S&F		27%
H&W,	Life,	Medic		19%
Life,	Medic			19%
H&W,	Life,	Medic,	S&F	16%
Life,	Medic,	S&F		16%

Table 28j. Activity Monitor Beige

Combo String				Count
H&W,	S&F			61%
H&W,	Medic			49%
Medic,	S&F			46%
H&W,	Medic,	S&F		41%
H&W,	Life			20%
Life,	S&F			19%
H&W,	Life,	S&F		16%
Life,	Medic			14%
H&W,	Life,	Medic		13%
Life,	Medic,	S&F		13%
H&W,	Life,	Medic,	S&F	12%

Smart Glasses. In the smart glasses, more variability and less consensus were seen (in any given selection combination) than in the previous product. No two domains were selected together by more than 30% in any given color, and no three domains were selected by more than 19% of viewing participants. These lower counts mirror the variability in the multiple selections.

In the previous sections, Gaming & Entertainment had been the most selected domain in almost every color, followed by Industry or Medical in most colors, or Communication. In approximately half (in the multiple-choice question) to more than two-thirds (in the single select question) of the colors, Communication had a lower individual count (counting every occurrence in single or combined choices) than Industry or Medical. However, in selection combinations, G&E and Communication were the most common selection combinations observed in all colors (except beige, where it was the second most common). Given that total counts for G&E in the multiple choice question ranged from a 55 to 64% selection rate, while Communication ranged from 33 to 45%, but that the combined occurrence of G&E and Communication selected together ranged from 20 to 35%, it can be deduced that nearly all individuals who selected Communication also selected G&E, and not the reverse. Most individuals who selected other domains also selected G&E, with comparable combination selection rates across combinations and products.

Medical and Industry (together or each in combination with another domain), were often high in subsequent combination rates displayed, appearing before the next combination containing Communication, but selection counts were generally comparable for selection combinations containing any of these three domains in a given color. That being said, between these three, Medical occurred much more frequently in combination with Industry or with G&E than it did with Communication. Accordingly, the more a Medical domain was seen, the less a Communication function was perceived.

Military was observed in the subsequent domain combinations. Military occurred in combination with all previously mentioned TDs, though less frequently in combination with Communication (in all colors except black), and at low but similar rates between colors. Additionally, in the colors white, purple, and pink, there were no (>10%) Military and Medical combinations observed. Military was also selected fewer times, in general, in these colors.

Additionally, Lifestyle, often a LL, E, or occasionally a ML TD, in almost all colors, always appeared first in combination with G&E or Communication before ever showing up in combination with another domain. Further, there was also no >10% selection of Lifestyle in conjunction with the Medical domain in any color except in the color beige (n=11%). The majority of those who saw the smart glasses as a Medical device did not think it was likely to have a Lifestyle purpose.

Other more unique findings imitate the previous section TD results: In beige, Medical and Industry were the most common domain selection combination, different from all other colors, where G&E and Communication were the most common combination; and in red, Security occurred much more frequently in combination with other domains—if at all—than in any other color. When Security did occur, it was in combination with Industry first, but differences between other Security-domain combinations was minute. Industry never appeared (>10%) in conjunction with Communication in the smart glasses. Participants who saw the product as an Industry device did not also associate it with Communication. **See Table 29**.

Table 29a-j. Smart Glasses Domain Selection Combinations in Each Color

Table 29a. Smart Glasses Pink

Combination String			Count
Comm,	G&E		34%
G&E,	Life		22%
Comm,	Life		21%
Indust,	Medic		21%
G&E,	Indust		20%
G&E,	Milit		17%
Comm,	G&E,	Life	15%
Comm,	Indust		13%
G&E,	Medic		13%
Indust,	Milit		12%
Comm,	G&E,	Indust	11%

Table 29b. Smart Glasses Purple

Combination String		Count
Comm,	G&E	26%
Indust,	Medic	22%
G&E,	Life	19%
G&E,	Medic	17%
Comm,	Life	16%
G&E,	Milit	16%
G&E,	Indust	14%
Medic,	Milit	12%

Table 29c. Smart Glasses Black

Combination String			Count
Comm,	G&E		35%
G&E,	Medic		22%
G&E,	Milit		22%
Comm,	Indust		21%
Comm,	Life		21%
G&E,	Indust		21%
G&E,	Life		21%
Indust,	Medic		21%
Comm,	Milit		19%
Indust,	Milit		19%
Medic,	Milit		17%
Comm,	G&E,	Life	17%
Comm,	Medic,		17%
Comm,	G&E,	Milit	14%
Comm,	G&E,	Indust	14%
Indust,	Life		14%
Comm,	Indust,	Milit	12%
Life,	Milit		12%
Comm,	G&E,	Medic	12%
H&W,	Medic		12%
Milit,	Secur		12%
Comm,	Indust,	Life	11%
Comm,	Life,	Milit	11%
G&E,	Indust,	Medic	11%
G&E,	Medic,	Milit	11%
Indust,	Medic,	Milit	11%

Table 29d. Smart Glasses Orange

Combination String			Count
Comm,	G&E		33%
Indust,	Medic		24%
G&E,	Medic		22%
Indust,	Milit		22%
G&E,	Indust		21%
G&E,	Milit		21%
G&E,	Life		20%
Medic,	Milit		19%
Comm,	Indust		18%
Comm,	Life		18%
Comm,	Medic		15%
Comm,	Milit		15%
Comm,	G&E,	Indust	15%
Comm,	G&E,	Life	14%
G&E,	Indust,	Milit	13%
Indust,	Medic,	Milit	13%
G&E,	Medic,	Milit	13%
Comm,	G&E,	Medic	12%
Comm,	G&E,	Milit	12%
Comm,	Indust,	Milit	11%
Comm,	Indust,	Medic	11%
Comm,	Medic,	Milit	11%
G&E,	Indust,	Medic	11%
G&E,	Secur,		11%
Indust,	Secur		11%

Table 29e. Smart Glasses White

Combination String			Count
Comm,	G&E		20%
G&E,	Life		18%
Comm,	Life		18%
G&E,	Indust		17%
Comm,	G&E,	Life	17%
Comm,	Indust		15%
G&E,	Medic		15%
G&E,	Milit		12%
Indust,	Medic		11%
Comm,	G&E,	Indust	11%
Comm,	Milit		11%
Comm,	G&E,	Milit	11%

Table 29f. Smart Glasses Yellow

Combination String			Count
Comm,	G&E		25%
Indust,	Medic		25%
G&E,	Indust		22%
G&E,	Milit		22%
Indust,	Milit		21%
Medic,	Milit		16%
G&E,	Medic		16%
Comm,	Indust		13%
G&E,	Life		13%
Indust,	Secur		13%
Comm,	Life		13%
Indust,	Medic,	Milit	13%
G&E,	Indust,	Milit	12%
Comm,	Milit		11%
Milit,	Secur		11%

Table 29g. Smart Glasses Beige

Combination String			Count
Indust,	Medic		32%
Comm,	G&E		24%
G&E,	Medic		21%
G&E,	Indust		20%
Medic,	Milit		20%
G&E,	Life		19%
G&E,	Milit		19%
Comm,	Medic		17%
Indust,	Milit		17%
Comm,	Indust		17%
Comm,	Life		16%
Comm,	Milit		15%
Indust,	Secur		15%
Comm,	G&E,	Life	14%
Medic,	Secur		14%
Comm,	Indust,	Medic	12%
Indust,	Medic,	Milit	12%
G&E,	Indust,	Medic	12%
G&E,	Secur		12%
Indust,	Medic,	Secur	12%
Comm,	G&E,	Milit	11%
Life,	Medic		11%
Milit,	Secur		11%

Table 29h. Smart Glasses Red

Combination String			Count
Comm,	G&E		31%
G&E,	Indust		29%
Indust,	Medic		24%
G&E,	Milit		22%
G&E,	Medic		20%
Indust,	Milit		20%
G&E,	Life		19%
Medic,	Milit		18%
Indust,	Secur		16%
Comm,	Indust		15%
Medic,	Secur		15%
G&E,	Secur		14%
Comm,	Life		13%
Comm,	Milit		13%
G&E,	Indust,	Milit	13%
Milit,	Secur		13%
Comm,	G&E,	Indust	12%
Comm,	Medic		12%
Comm,	G&E,	Life	11%
Indust,	Medic,	Milit	11%
Comm,	G&E,	Milit	11%
G&E,	Indust,	Medic	11%
G&E,	Medic,	Milit	11%
Indust,	Life		11%
Indust,	Medic,	Secur	11%

Table 29i. Smart Glasses Green

Combination String			Count
Comm,	G&E		34%
Indust,	Medic		31%
G&E,	Medic		27%
G&E,	Indust		26%
G&E,	Milit		23%
Comm,	Life		23%
Medic,	Milit		19%
G&E,	Life		17%
Comm,	Indust		17%
Comm,	G&E,	Life	16%
G&E,	Indust,	Medic	16%
Indust,	Milit		16%
Comm,	Medic		15%
Comm,	Milit		15%
G&E,	Medic,	Milit	14%
Comm,	G&E,	Indust	13%
Comm,	G&E,	Milit	13%
Indust,	Medic,	Milit	13%
Comm,	G&E,	Medic	12%
G&E,	Secur		12%
G&E,	Indust,	Milit	12%
Indust,	Secur		12%
Medic,	Secur		12%

Table 29j. Smart Glasses Blue

Combination String				Count
Comm,	G&E			33%
Indust,	Medic			30%
G&E,	Indust			28%
Comm,	Indust			23%
G&E,	Life			23%
Indust,	Milit			23%
G&E,	Milit			22%
Comm,	Life			21%
G&E,	Medic			21%
Comm,	G&E,	Indust		18%
Comm,	G&E,	Life		16%
G&E,	Indust,	Milit		16%
Comm,	Medic			16%
Comm,	Milit			16%
Indust,	Life			16%
Medic,	Milit			16%
Comm,	G&E,	Milit		13%
G&E,	Indust,	Medic		13%
Indust,	Medic,	Milit		13%
Comm,	Indust,	Milit		12%
G&E,	Indust,	Life		11%
Comm,	G&E,	Indust	Milit	11%
Comm,	G&E,	Medic		11%
G&E,	Medic,	Milit		11%

Neurostimulation Headband. In the headband, more consensus was observed than in the smart glasses, but combination selections were not quite as high as those observed for the activity monitor. H&W and Medical were the most common selected combination in every color of the headband, the highest count (54%) for which was observed in beige. In beige, every >10% combination observed included Medical in the selection.

Interestingly, S&F was observed in the next highest combination in almost every color, with either H&W and separately with Medical in similar or identical counts. Still, selection rates were generally low. Beige had the lowest selection of S&F (in combination with H&W) at 11%. Selection of H&W, Medical, and S&F together was lower for all colors. Other selections with >10% selection rates were Communication and G&E (TDs in only green and blue), though the count was always low. Neither occurred in conjunction with S&F in any of the displayed >10% domain combinations. Further, strong trends in combination hierarchy were not observed with these two domains. However, each occurred slightly more frequently paired with Medical than with H&W or with each other. For example, Communication showed up consistently with Medical in all colors (except orange), but less frequently with H&W. A Medical association was distinct for this product. **See Table 30.**

Table 30a-j. Headband Domain Selection Combinations in Each Color

Table 30a. Headband Yellow

Combination String			Count
H&W	Medic		41%
H&W	S&F		19%
Comm	Medic		17%
Medic	S&F		17%
H&W	Medic	S&F	15%
Medic	Milit		13%
Comm	H&W		12%
G&E	Medic		11%

Table 30b. Headband White

Combination String			Count
H&W	Medic		49%
H&W	S&F		22%
Medic	S&F		22%
H&W	Medic	S&F	19%
Comm	Medic		16%
Comm	H&W		15%
Comm	G&E		11%

Table 30c. Headband Red

Combination String			Count
H&W	Medic		48%
Medic	S&F		23%
H&W	S&F		18%
G&E	Medic		17%
H&W	Medic	S&F	16%
Comm	Medic		15%
Industry	Medic		13%
G&E	H&W		11%
G&E	H&W	Medic	11%
Comm	G&E		11%

Table 30d. Headband Purple

Combination String			Count
H&W	Medic		47%
Comm	Medic		16%
H&W	S&F		15%
Medic	S&F		14%
Comm	H&W		13%
Medic	Milit		13%
Comm	H&W	Medic	11%
H&W	Medic	S&F	11%
Comm	G&E		11%
G&E	Medic		11%

Table 30e. Headband Pink

Combination String			Count
H&W	Medic		51%
H&W	S&F		24%
Medic	S&F		24%
H&W	Medic	S&F	20%
Comm	Medic		15%

Table 30f. Headband Beige

Combination String		Count
H&W	Medic	54%
Comm	Medic	16%
G&E	Medic	12%
Medic	S&F	11%

Table 30g. Headband Blue

Combination String			Count
H&W	Medic		39%
Medic	S&F		20%
H&W	S&F		19%
Comm	Medic		17%
H&W	Medic	S&F	16%
Life	Medic		11%

Table 30h. Headband Orange

Combination String			Count
H&W	Medic		41%
H&W	S&F		18%
Medic	S&F		18%
H&W	Medic	S&F	12%
H&W	Life		11%

Table 30i. Headband Green

Combination String			Count
H&W	Medic		38%
Comm	G&E		18%
Comm	Medic		15%
H&W	S&F		14%
G&E	Medic		13%
Medic	Milit		12%
G&E	H&W		11%

Table 30j. Headband Black

Combination String			Count
H&W	Medic		43%
G&E	Medic		15%
Medic	S&F		15%
Comm	Medic		15%
H&W	S&F		15%
H&W	Medic	S&F	12%
Comm	G&E		11%
Medic	Milit		11%

Qualitative Responses

Thirty-seven percent, or 522, of the total participants (45 to 61 per product-color) answered additional questions regarding device recognizability and assumed functions. After viewing each product and selecting assumed domains, these MTurkers described what they presumed the product to be and whether the device was recognizable to them or not. After viewing all three products, they then answered questions about the recognizability of the term wearable technology and its application to the products they had been shown. Responses were collected for each product-color; however only summary findings for each product (all colors combined) will be presented and more in-depth breakdown and analysis will occur in future study steps.

Assumed Purpose/Functions. Responses collected for each color version of each product were combined for each of the three separate products. Summary findings for the three products are displayed below. To briefly summarize and present MTurker's assumptions about specific functions and purposes for each product, word clouds were created for all responses regarding the activity monitor, smart glasses, and headband. Common words (e.g. “the,” “in,” “or,” etc.) were first filtered out.

Activity monitor. As can be seen in the word cloud, the activity monitor was very often described exactly as such. Health, fitness, exercise, and heartrate tracking or monitoring, and related words, were common mentions, as was the activity monitor brand FitBit (e.g. “It’s an armband that has a device attached like a Fitbit or something. It can measure heart rate, calories burned, steps walked, etc. for health tracking”). Although not visible in the word cloud, it was also discovered (after reviewing the comments) that only one participant correctly identified the activity monitor as the BodyMedia Link brand. When not described as directly measuring activity/health, the product was still almost always described as being used in conjunction with a health related activity (e.g. “It looks exactly like an iPod or other mp3 player that a jogger or very athletic person might wear”). As seen in the example, sometimes assumptions about the possible wearer were imagined. **See Figure 5**.

Figure 5. Activity Monitor “what would you assume the product is and does?”

Smart glasses. The smart glasses were frequently described in comparison to the brand Google Glass, or simply glasses, and there were common mentions of information and internet access (e.g. “This looks like a bulkier version of Google Glass. It is meant to record video and take pictures from a first-person point of view. It records these videos and puts it directly on social media and YouTube”). A camera or recording device was mentioned by many. Gaming and VR were also cited often (e.g. “I think this is a gaming headset that plays your game onto your eyes”). Alternatively, the product was frequently described instead as a magnification tool for doctors, jewelers, and others who worked with small parts (e.g. “This product is probably used for magnifying small objects. Someone like a jeweler could use it to cut a diamond and check for imperfections. It might also have a light to shine on the object”). No participants named the real product brand name. **See Figure 6**.

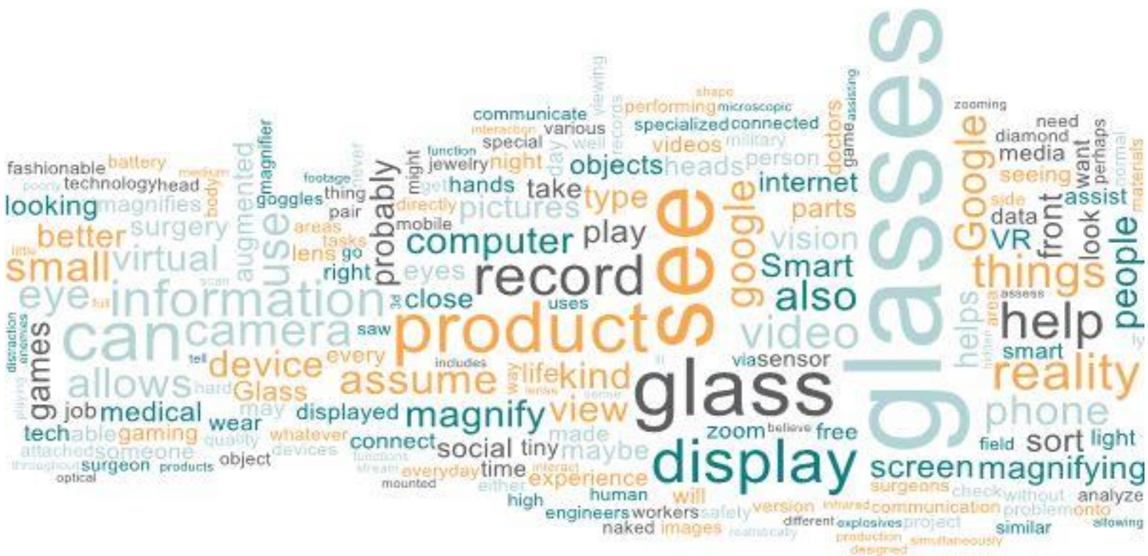

Figure 6. Smart Glasses “what would you assume the product is and does?”

Neurostimulation headband. The headband was most commonly described as a medical device for brainwave analysis or monitoring (e.g. “Maybe senses brain waves. Possibly sends brain activity feedback to a computer”) or compared to a hearing aid (e.g. “It looks vaguely like a hearing aid, but I'm not sure”). Also commonly proffered was the idea that it might be used to treat headaches/migraines (e.g. “I believe this device is used to relieve maybe headaches. The way it is positioned above the eye. Maybe for tension headaches”). Only one participant named the actual product brand, Thync, and a handful of participants discussed the function of stress relief (e.g. “I assume it monitors your brain waves… or perhaps even administers drugs or some kind of stress relieving tools”), but these comments were far less common than other previously mentioned assumptions. Also mentioned by a few people were headset devices (e.g. “Looks like some sort of communication device. Perhaps a microphone or headset piece”). **See Figure 7**.

Figure 7. Headband “what would you assume the product is and does?”

Mentioned across all three products—and referring to a feature that was not of the product itself—was body location or body parts near the products (e.g. on the headband, “It looks like an eye patch that is worn a little too high on the face”); also possible user of the product (e.g. on the smart glasses, “eye doctors can use this”); and context-of-use scenarios (e.g. on the activity monitor, “I think this is a device for measuring your pulse during a workout”). Although comments on the activity monitor tended to focus on the arm and comments on the smart glasses tended to focus on the eyes, comments on the headband ranged from forehead to ear to eyes. On a similar note, more variety on possible scenarios or users was seen in the smart glasses and the headband than in the comments on the activity monitor.

Recognizability. Frequency data on whether or not participants thought each device was recognizable shows that almost all individuals recognized the activity monitor (81%) and smart glasses (75%), but that very few recognized the headband (23%). However, when quickly reviewing the descriptive responses on these selection, it was found that 2 to 3% of individuals for the activity monitor and the smart glasses misunderstood the question or likened "recognizability" to visibility (e.g. "It's fairly distinctive and appears like something that would stand out on someone" or "The device sticking out beyond the glasses are noticeable"). Whether or not a similar count of misunderstanding occurred for the headband was unclear: no explicit remarks were made regarding visibility, etc. **See Figure 8**.

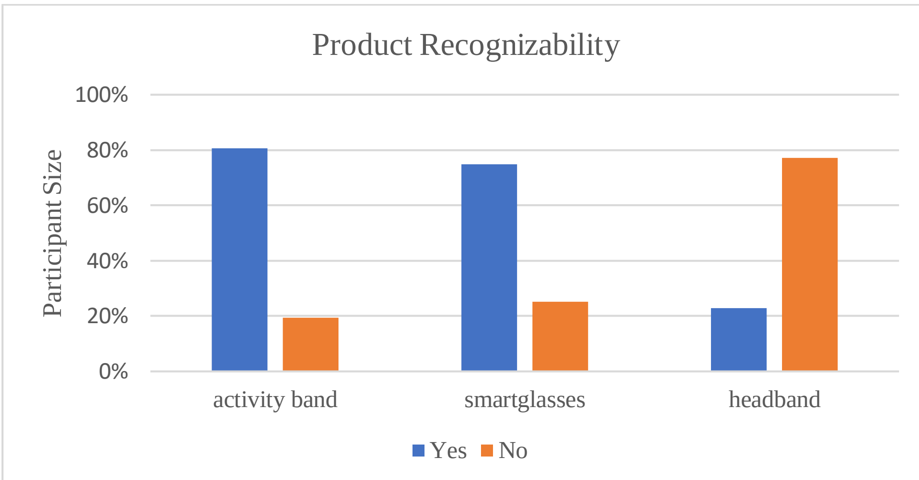

Figure 8. Is this product recognizable?

Summarized responses of participants recognizability explanations are presented as word clouds for the activity monitor, smart glasses, and headband. Although detailed statistics and review are in the future steps of this study, descriptions strongly mirror previous responses describing the assumed functions of the products. However, more prominent in these word clouds than in the previous word clouds were the sizes of the words representing the brand names mentioned earlier. Further, though participants made many guesses regarding the headband's purpose, many of which were consistent across the group, the majority specified that they had never seen this product before and were purely guessing (e.g. "I'm just guessing based on the positioning"). **See Figures 9-11**.

Figure 9. Activity monitor recognizability

Figure 10. Smart glasses recognizability

Figure 11. Headband recognizability

Color Mentions. Following these findings, key word searches were used to scan all responses for any mentions of color. Only eleven participants (2%), 6 for the armband, 3 for the smart glasses, and two for the headband, mentioned either the word "color," or a specific color in their responses. Such mentions were stated mainly to describe what was seen (n=3, e.g. "The black line is nearly on top of where…"), or to explain why they thought the product would be visible/recognizable (n=4, e.g. "It's bright yellow and goes around your arm on top of your clothes"). Others (n=4) suggested that there may be other colors for these products. For example, the activity monitor "may come in different colors;" and the smart glasses appeared to be "recolored Google Glass." Only one person verbally associated color to a domain: "I've seen fitness bands look this[sic], though not pink which maybe could indicate actual medical stuff it tracks beyond wellness traits like heart beat."

The Products as Wearable Technologies. When asked if the term "wearable technology" was recognizable, a vast majority of the individuals (97%) answered Yes, the term wearable technology was recognizable. However, 6% of those who selected Yes provided answers that either contradicted their selection (e.g. "Don't really hear it used, but seems like an obvious term") or indicated possible misunderstanding (e.g. "yes it[sic] something easy to understand"). When asked to explain their answer, most participants (41%) defined what wearable technology was (e.g. "It is something advanced that you wear not dissimilar to smartphone or the likes"), and, as seen in the previous examples, (40%) provided a product or brand as a reference.

Brands frequently mentioned included FitBit, Google Glass, and Apple (e.g. "Wearable technology includes Apple Watch, Fitbit, Google Glasses, and generic versions of each"). Products frequently mentioned included "smart" items, including watches, glasses, phones, etc. (e.g. "wearable technology is like a smart watch"); and general fitness or health trackers/monitors ("There are fitness anklets and bracelets that tracks heart rates"); and a smaller mix of miscellaneous products (e.g. "It's very common in today's age. VR headsets to bluetooths"). It was also occasionally unclear whether certain products mentioned were wearable technology in the modern definition, or whether participants were discussing traditional items (e.g. "Tech that you wear such as a watch"). The "Other" category (8%) displayed below represents both (6%) possible misunderstanding of the question (e.g. "You can wear it, and it's easy to tell if it looks new or unique) and (2%) uncategorized responses (e.g. "wearable technology are more convenient and extremely useful"). **See Figure 12**.

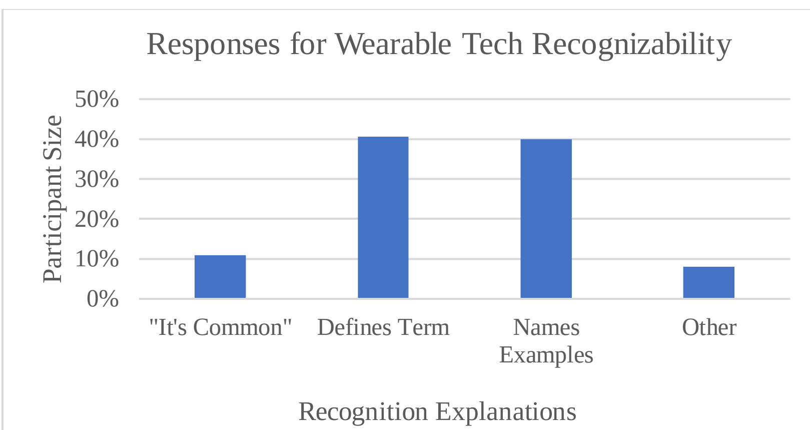

Figure 12. "Is the term wearable technology recognizable?"

When asked whether participants would have categorized the previously displayed products as wearable technologies prior to taking the survey and seeing the term used, almost all participants (94%) selected that they would have categorized at least one of the products as a wearable technology, the most agreement being with the activity monitor (82%) and then the smart glasses (78%). To note, these products were only described as armbands and glasses in the survey questions, to avoid the technological association in the words monitor and smart. Less than half of the participants (43%) selected that they would have categorized the headband as a wearable technology, which is somewhat higher than the recognizability rate discussed in the previous section. Thus, participants assumed the device had some technological purpose despite not recognizing the specific product. **See Figure 13**.

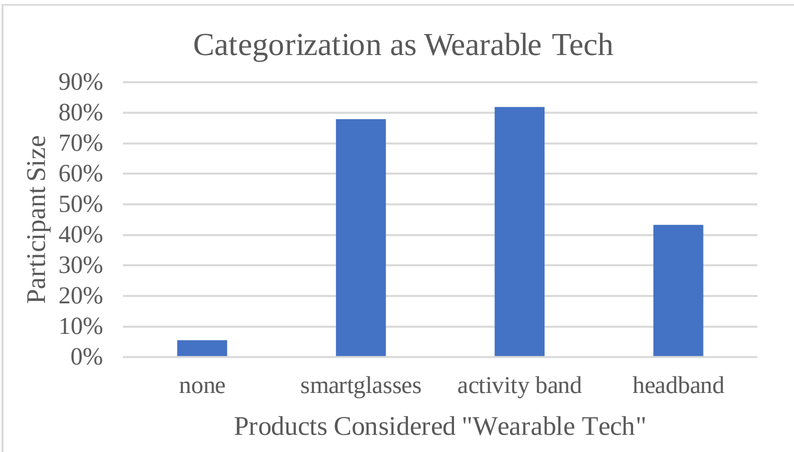

Figure 13. "Would you have categorized this item as wearable technology before taking this survey?"

Chapter V

Discussion

This section summarizes and discusses the results. Within each product, there were consistent perceived domain assumptions generally regardless of the applied color, but there were indications of some color influence. However, stronger than color were the trends seen in product-domain associations and domain-domain relationships.

Findings Between Final Study Products

Across the second iteration (improved color application) products, there was some consistency, though no strong statistical findings, in perceived domain and color—namely, in the relationship between the application of the color beige and the selection of the Medical domain. Given that the Medical domain appeared in each product and most colors (e.g. Medical was a High Level TD in all color versions of the headband), strong conclusions cannot be made, but many findings point to a relationship between these two variables. Medical was a High Level TD in the beige activity monitor but a Mid Level TD in all other colors of the product, and it was selected more times in beige than in all other colors in the single select question. In the smart glasses, Medical was a HL TD in the beige product—and although it was also a HL TD in several other colors, in beige, Medical was the most selected domain overall (whereas G&E was the most selected domain in all other colors). And, in the headband, Medical was selected at a similar rate in every color (no significant differences), but regardless, its highest selection rate was in beige. These results support past literature that suggested associations between the color beige and medical devices (Kelly & Gilbert, 2018; Koo, et al, 2016; Stipe, 2017; Starner et al., 1999). Medical was also a Top Domain in every product in this study, including the piloted products.

Conversely, despite the high Medical selections, similarly consistent findings were not found between Medical and the color white as was reported by Häkkilä et al. (2015), Hochberg (2007), or Starner et al. (1999). This may simply be due to color in general having little effect on domain perception for these products, or due to the increase of the color white in a variety of non-medical consumer electronics following the rise and popularity of Apple Inc. products in the early 2000s. Apple was one of the brands frequently mentioned in the open-ended questions, and white is a common color across all of the brand's product categories—which span primarily lifestyle, communication and entertainment devices.

Color and Relative Top Domain Order

In each product, there were consistently observed Top Domains in every color. However, in each of these products, the relative prominence of the Top Domains varied from color to color (most obviously observed in the smart glasses). What *is* clear from the Top Domain trends is that there are consistent product-domain associations for each of the three products—that there are a select number of salient perceived domains in the activity monitor (S&F, H&W, Medical, Lifestyle), the smart glasses (Industry, Medical, Communication, Military, Lifestyle), and the headband (Medical, H&W)—reasons for which are discussed in subsequent sections. What is *unclear* is whether the various relative differences between the salient domains in any given color are due to the color, or due to the participant sample variation. Each product was viewed by a different participant group, with a different set of personal experiences and knowledge. Thus, one groups' product-associations may differ slightly from the next, especially with products that are multi-functional/multi-domain applicable.

Take, for example, the smart glasses in orange and in black. In black, the Top Domains were as follows: G&E (HL), Medical (HL), Communication (HL), Industry (ML), Military (ML), Lifestyle (EL). In orange, the same domains were observed but the relative order was different: G&E (HL), Industry (HL), Medical (HL), Communication (ML), Military (ML), Lifestyle (EL). Without asking participants directly, it is difficult to determine whether color affected the relationship between these variables (e.g. did black highlight the Communication aspect of the other Top Domains, thus slightly increasing its count and giving it a HL status in this color? or did the group who observed the black smart glasses simply happen to have more firsthand knowledge of the smart glasses' communication capabilities?). Because these answers cannot be easily discerned from the data, possible reasons for color differences in each product will be discussed in the following sections, but the crux of the discussion will focus on the product-domain associations rather than the colors.

Activity Monitor and Arm Worn Device Domains

The final study-version activity monitors were seen predominantly as a S&F and

H&W (all HL) product, and just as commonly but less dominantly as a Medical (almost always ML) product in every color. Lifestyle was a smaller count TD in some colors and fourth most selected domain in all colors. Tests comparing the Top Domains as single variables, such as S&F alone, across all colors, also showed no significant differences. And although one participant indicated that pink was associated with Medical (e.g. “pink…maybe could indicate actual medical stuff”), a yellow blue, green, red, etc. activity tracker was equally viewed as a Medical product. Similar consistency in selections were observed in the piloted colors. Perceived product domains/functions were consistent and salient; color did not affect the likelihood that this collection of domains would be associated with the activity monitor.

However, the relative prominence of TDs (e.g. Medical vs Lifestyle) in comparison to one another, did vary in some colors of the activity monitor. For example, in beige, H&W, S&F, and Medical were all High Level TDs (not significantly different in count), while in all other colors, Medical was a ML domain. Similarly, Lifestyle was a TD in only some colors, not in all. Lifestyle was the fourth most selected domain in every color, but wherever it occurred as a TD (yellow, purple, pink, orange, blue, and black)—it was because of its relative distance from Medical. When Medical had a slightly lower count, it pulled Lifestyle as a TD, due to TD count difference rules. When Medical had a slightly higher count, Lifestyle was significantly smaller in count but also below the 30% threshold.

For a perceived activity monitor, if a Medical function was even slightly more pronounced, a Lifestyle function was less observable, or vice versa. This conclusion is supported by the combinations frequency results, which showed that Lifestyle was more frequently selected in combination with S&F or H&W than it was with Medical. Lifestyle was defined as used for “general” tasks, and “general” may be understood as common to any/most. The more Medical a product’s appearance, the more its functionality seemed specific—perhaps to the type of user (e.g. a patient) or assumed use-setting (e.g. hospital)—and less general/applicable to non-medically related purposes. Similar reasoning could explain why Medical occurred more frequently with H&W than with S&F: Medicine, or medical practice, is done explicitly and directly to improve or maintain a person’s health, and while physical activity may be a prescribed means to do so, the relationship is not as direct.

The actual product used as stimuli in this study, however, is not advertised as a medical product. Vandrico has the product listed only as a Fitness and a Lifestyle product. Vandrico does not have Health & Wellness as a domain option on its site, but actual advertisements for the BodyMedia activity monitor describe it as “a powerful weight loss tool supported by [a] Health and Wellness expert.”[4] Many participants, however, clearly saw a Medical function in the product. The majority of participants also selected that they recognized the product, alone, and later as defined as a wearable technology. Per the open-ended responses given by participants it is clear that the more specific features of the product are seen as shared by Medical products (e.g. heartrate monitor), and that the purpose of the product (e.g. improving health through activity) was the most salient aspect.

These findings are unsurprising. As described by Cosco (2016), the activity monitor was one of the premier wearable technologies to gain notice and popularity in the consumer market. Further, given the dominance of S&F and H&W domains in the wearables market (Berglund et al, 2016) and the commonality and acceptance of the arm as body placement (Berglund et al., 2016; Profita et al., 2013; Silina & Haddadi, 2015; Zeagler, 2017) and thus greater public prominence, it was highly probable that observers would connect an arm band to those domains. Health and fitness related activities and functions were the most frequent responses. Of course, the influence of the FitBit brand cannot be ignored. FitBit’s influence over MTurker’s knowledgebase and experience was prominent. Again, this is not surprising. FitBit was the number one (wearable tech brand) spender on advertisements when the field was growing in production and recognition (Aditi, 2015). FitBit was the most frequently mentioned activity/health brand mentioned by MTurkers by far. These findings are also supported by industry reports of the largest wearables vendors and product shipments (IDC, 2019b; Richter, 2018).

Such domain association explanations are also applicable to the findings for the arm worn products that were tested in the pilot study. As observed in the domain summary table, though some differences were found, there were similar Top Domains of Medical, H&W, and S&F for all three arm worn products. Biosensing functions are relevant to Medical, H&W and S&F domains, most wrist worn wearable technologies are developed

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[4] https://pisces.bbystatic.com/image2/BestBuy_US/images/products/3440/3440508cv6a.jpg

for medical, healthcare, and fitness related fields (Al-Eidan et al., 2018; Parola Analytics, 2018) and biosensing wearable technologies are most commonly located on the wrists and arms (Parola Analytics, 2018; Zeagler, 2017). This suggests a substantial influence of body location over domain perception for arm worn technologies. While the exoskeleton arm support is actually related to the health and fitness of the body, the gesture band is not; the gesture band is a remote control for other electronics. Yet, the gesture band, perhaps both in its location and its presentation as a banded item, shared even more similarities to the activity monitor arm band than did the exoskeleton arm support (e.g. Lifestyle as a TD, and a greater number of colors observed with S&F and H&W selections compared to the arm support product).

However, even as a band, it is dissimilar in shape to standard activity monitors. On the gesture band, there is no central "monitor" component, nor is it a singular band; rather it consists of many repeating squared edges. The repeating shape, and smaller size of the band, is evocative of more decorative items, such as beads. Of course, the shape and size of the products are not ignored in favor of the body location. Although open-ended responses for the piloted products were not collected, it is surmisable that the gesture band's beadlike shape, in relation to the body location, drew associations to jewelry (bracelets), and was reason for the frequent Fashion (aesthetic) domain selections, a domain not observed in the activity monitor or arm support. Similarly, the exoskeleton arm support's full arm coverage is similar to an arm sleeve, though much more squared and rigid, which might have evoked armor images and hence, Military domain results (again, not observed in either arm band product). Color may have come into play in these selections as well, but color results from the pilot are less discernible due to the discussed limitations.

Smart Glasses and Eyewear Product Domains

The smart glasses, like the activity monitor, were also highly recognized by most participants, though assumed domains were less concise. In every color of the final version smart glasses, G&E, Industry, Medical, Military, and Communication were Top Domains; and in every color except yellow, Lifestyle was a Top Domain. G&E in particular was always selected by more than 50% of the viewing participants. In the single select question, G&E was almost always the most selected domain, but there was no sample majority (50%+) consensus on any single "most likely" domain in any color. Rather, again, color was seen to affect the relative order and count between these major TDs in the multiple-selection questions. Aside from the differences in relative order of TDs, the most distinct differences in TDs were seen in the yellow and in the red smart glasses, while some weak but noteworthy trends were observed in the beige smart glasses.

When the smart glasses were yellow, Lifestyle was not a TD—neither was Lifestyle's count near the 30% threshold, as it was in other colors. Perhaps in yellow the smart glasses were too attention-grabbing for "general day-to-day" use, as yellow is a particularly bright, stimulating color. Yellow is also consistently ranked as one of the least preferred colors in the US and a variety of other countries, and across time (Eysenck, 1941; Madden, Hewett, Roth, 2000; Yu et al, 2018), and thus may not be highly desirable to wear on a "day-to-day" basis as would be indicated by Lifestyle. Further, glasses are worn centered on the face, the focal point of social interaction and therefore the most attention-grabbing body location, and would only heighten the focus on the color. Color was almost never mentioned by any participants in the open-ended questions, but for the yellow smart glasses one MTurker did name yellow as the reasons why the product was visibly recognizable.

Alternatively, or relatedly, this could be due to the association between yellow and caution signage in occupational settings (OSHA, n.d.), as Industry (described as a job performance domain) was a HL Top Domain in the yellow glasses. Industry appeared as a TD in all other colors, but in conjunction with yellow, the two may have negatively affected the possibility of the product also being a Lifestyle device.

Similar, though opposite effects may be reason behind the unique observation in the red smart glasses: the only unique TD finding in this product. When the smart glasses were red, the domain Security/Safety was a Top Domain. It was an Exception level (26%) TD, pulled by the Medical domain (lower and closer selection count) per TD rules, but selected at nearly equal rate in combination with Industry (16%) as with Medical (15%). Red, in occupational settings, indicates that danger is near (OSHA, n.d.), and does so to keep workers safe. Red may have highlighted the protective function of the lenses as barriers for the eyes.

Finally, a unique, but not significant finding was observed in the beige colored glasses, as mentioned in previous paragraphs. In all colors except beige, the most selected domain in the multiple-choice question was G&E, but in beige, Medical was the most selected domain. In the single choice question, the most selected domain varied from color to color, but in beige, the most selected domain was still Medical. Significant differences were not found, and both G&E and Medical were High Level domains (not significantly different in count) in almost all colors—but it is a noteworthy observation, given the past reports on a Medical association with this color in specifically heads up displays (Starner et al., 1999).

In all other colors, the Top Domains varied in TD Level—but not drastically. G&E, Industry, Medical, and Communication were always HL or ML domains and can be seen as the most salient, likely, or known product domains regardless of color. Military and Lifestyle were frequently fairly low in count, and were thus the less salient, likely, or known product areas.

What is most interesting is that the smart glasses were highly recognized as both a product and as a categorized wearable technology. This is interesting not because of its ranking, as it is in line with industry reported recognition (Gartner, 2018; Statista 2017) and academic focus (e.g. Al-Eidan, 2018)—it is interesting because of the greater number of selected Top Domains *and* the smaller consensus on each. One may conclude that smart glasses are a particularly versatile, multi-functional, and domain-applicable tool. The product is advertised as such: Vandrico lists Gaming, Entertainment, Industrial, Lifestyle, and Medical as potential product usage areas—all participant-selected TDs. And, while neither Military nor Communication were listed on the Vandrico product page, the description did name the device as a means for increasing communication. Data glasses and heads up displays are also items used in the military.

On that note, there were similar domain findings between the smart glasses and the piloted AR device (which can also be classified as a heads-up display). The AR product was assumed in most cases to be a G&E, Industry, Military, Security, and occasional Medical or S&F product (Communication was not an option in the pilot). Vandrico's listings for this product were Gaming, Entertainment, Lifestyle, and Industrial. And like the smart glasses, in the AR product, G&E was almost always the most selected domain regardless of color. As was postulated for the previously discussed product groupings, reasons for the AR domain results, and lacking domain results (e.g. Lifestyle) may fall in line with explanations given for the smart glasses (i.e. similar form, function, location).

Returning back to the smart glasses and more detailed results: despite the consistency between the TDs and advertised domains across colors, a high majority selection was not observed on all Top Domains nor on those mirroring Vandrico's listed areas. If all domains were seen as equally likely contexts, or equally salient to all participants, then the sample selection rate would be high, and comparably so, on all TDs; however, this was not the case. These findings imply that although the majority of participants recognized the product as a wearable technology, with many agreeing on what the appendage was, the purpose or use of that specific technology as it related to the needs of a potential wearer or context-of-use scenario was far more ambiguous and susceptible to individual subjectivity than the activity monitor. Similarly, the AR product did not frequently have domain selection rates exceeding 50%. There were less dominant group-shared associations for the products compared to the activity monitor, thus indicating less shared experiences.

In the smart glasses open ended results, Google's smart glasses brand, Google Glass, like FitBit, was a highly mentioned brand name in the recognition responses. When Google Glass was first introduced to the consumer market circa 2013, the product was heavily covered in the news (Simons & Chabris, 2013) and clearly penetrated the public conscious. However, the product faced severe pushback due to perceived privacy concerns related to the recording aspect and the negatively perceived user identity ("Glasshole") associated with the high price and very visible display of the product (Gross, 2014). The product was removed from the consumer market in 2015, but reintroduced into the workforce (Cakebread, 2019). This was even mentioned by one MTurker: "Well it reminds me of Google Glass which now is marketed towards industrial purposes." Thus, while many may have heard of smart glasses, the likelihood of encountering a pair in the wild is unlikely. In addition, aesthetically, the product in this study in particular was described as bulky and unattractive. Negative perceptions of acceptability/normality and of (un)attractive design are obvious hindrances to wearable technology use, as such aspects would be perceived as products with potential for reflecting negatively on the wearer and their identity (Dunne, 2010; Dunne, Profita, & Zeagler, 2014). Past literature also describes the assumed belief that bulky and unappealing designs must be related to working or medical environments, where the necessity supersedes personal appearance requirements (Häkkilä et al., 2015; Nguyen at al., 2009). Most reports point to negative perceptions of publicly used smart glasses, although most reasons were related to its function as a recording device (Denning et al., 2014; Gross, 2014; Koelle et al., 2015; Profita et al., 2016). And, while past literature reported a comparable interest in headsets/eyewear to wristwear wearables (Statista, 2017), the questions were framed by the gaming and virtual or augmented reality fields, not the public space. Thus, similar explanations on less salient and shared experiences may exist for the AR product, which is far bulkier than the smart glasses, and specifically centered around augmented reality functions.

The trends in the smart glasses' combinations data and descriptive responses further elucidate the findings. In general, G&E was selected at a comparable rate in combination with all other TD domains for the smart glasses. Selecting G&E did not appear to negatively influence the selection of other TDs. The majority of individuals who viewed the glasses mentioned either a computer, display screen, data, camera, or other recording functions, etc. All the aforementioned terms can be used for work *or* recreation; therefore, Gaming & *Entertainment* could cover all possible recreational activities. Further, there were many comments mentioning virtual or augmented reality, likely because of the appendage and camera in front of the glasses' lens (augmented reality refers to augmenting your senses, typically through vision overlay). Augmented reality is advertised in both gaming and industrial markets. The non-G&E domain selections were likely relative to the specific type of work possibilities the participant believed, knew, or expected the product to be used for. Industry, Medical, and Communication were the next most selected TDs, varying in prominence from color to color, but generally sharing trends in selection combination.

Medical occurred more frequently in combination with Industry than it did with Communication. Respondents who described the product as a medical device often stated that it was a type of vision enhancing tool for doctors, a tool "used by someone to perform their job" as was defined by Industry. There was a more direct relationship between these domains, as the role of a professional was the aspect being considered. Similarly, Industry and Communication were almost never selected in combination. Military, a lower count

TD, was selected fewer times overall but in comparable combinations with either Medical or Industry, and less often with Communication. Participants appeared to be more focused on the type of industry or work the product would be used in. Military was perhaps an alternative, but less common occupation requiring such a tool. In fact, much of the data glasses and heads-up displays development originated in the military (Ryan, 2014), but laymen are unlikely to be very familiar with the field's history. The public has limited access to the products used and developed by the military compared to other sectors.

Again, the Military selection reasons directly apply to all heads up displays, and therefore the AR device, while the display screen mentions and augmentation functions also explicitly relate to the product and therefore relative domain selections. Such functions and forms were likely deduced through the product's lens (vision coverage) and bulky rigid form—which is typical of electronics (Dunne, 2010). For the Medical selections, it is possible that similar reasons to those given for the smart glasses exist for the AR product (i.e. vision tool). However, an alternative explanation might also focus on the head coverage rather than only the eye coverage/appendages: it is possible that the AR headset, in its full head coverage and rigidity/bulkiness, also procured helmet (head/health protective) associations in the minds of participants. Such an image would also explain the S&F and the G&E selections seen in the AR product: similarly sized and shaped helmets, with eye coverage, are used in gaming sports like paintballing.

Finally, Lifestyle (generally a minor level TD) was always observed in combination with G&E or Communication before any other domain in the smart glasses results. Those who selected Lifestyle may have focused more on the everyday applicability of functions relative to G&E or Communication (e.g. information sharing and/or recreation)—while those who selected G&E or Communication, and not Lifestyle, may have been more focused on the "tool" aspect, and thus the job-specific relationships in those domains. For example, similar findings were observed between Lifestyle and Medical in the smart glasses as in the activity monitor: Lifestyle was rarely, if ever (>10%), selected by participants who selected Medical. The medical glasses described by participants were used in specialized, professional, non-common scenarios (e.g. surgery). This also explains why H&W was not a TD in the smart glasses. H&W was defined as a product used by the "everyday person." Other explanations come back to the discussion of bulkiness and ugliness—which are features expressed as undesirable for general consumer products. The smart glasses were described as such, and the AR products are, at least, objectively bulkier than the glasses. Although sub level TDs were not utilized in piloted products, and therefore it is possible that these domains might have been LL TDs in the AR product, neither H&W nor Lifestyle were Top Domains in any color of the AR device.

Neurostimulation Headband and Headgear Domains

In the final version of the headband, the product was overwhelmingly assumed to be a Medical and Health & Wellness product, regardless of color. Brain monitors/sensors, and hearing aids were common assumed functions. However, other, though far less dominant, domains were Top Domains in a select few colors: G&E in green, S&F in pink, and Communication in green and blue. That being said, similar reasons as seen in the previous products account for their occurrence: either a lower count in one of the HL TDs pulled a lower level domain to a Top position, or the sub level domain made it to the 30% threshold. S&F and Communication tended to be fairly consistent in count across colors, but generally ranked below the threshold. For example, although the count for Communication was comparable in most colors, in green, H&W were selected fewer times than it was in other colors (below 50%) and in return, Communication was seen at a slightly higher rate. This could possibly be due to color effect. The colors may have negatively influenced the perception of the item as for the everyday, or inversely, made the item look more like a headset and less like a health monitor, etc. Or, as became evident in the open-ended responses, differences could be due to variation in the viewing participants' own domain definitions and interpretation. For example, multiple participants stated that the headband might be a hearing aid, which was most often categorized as a Medical device. Some, but not all, of these participants also categorized the possible hearing aid as a Communication device. A product that facilitates hearing would certainly facilitate communication. The same product was assumed, but how each participant categorized the product, or interpreted the domain definition, differed. As each product-color was seen by a unique group of people; some variation is expected. On that note, however, is a reminder that the open-ended responses describing product function were not analyzed separately by color, but as one unit/all colors combined. Therefore, while combination data showed that Medical and Communication were selected together at similar rates in every color, it is uncertain whether there were an equal mix of individuals per product-color who described specifically a hearing aid as only a medical product as there were those who described a hearing aid as a medical and communication product, or if there were uneven ratios in different colors. As an aside, Communication was also chosen by those who saw the product as a G&E device of some sort (e.g. headset), this combination *was* slightly higher in green than Communication plus Medical, and similarly related to auditory augmentation, but overall, Communication was more commonly selected with Medical.

Similarly, S&F was selected in combination with Medical or H&W more frequently than with any other domain. A quick look at these responses revealed that numerous respondents still guessed the product to be a brain monitor of some sort, or a hearing aid. It is plausible that the concept of a monitor called forth a S&F relationship, as this was a strong function-domain association that participants had for the arm band. Similarly, brainwaves are one measurement type used in biofeedback monitoring, an activity that often occurs in physical therapy or clinical settings (e.g. a Medical domain), that may be used to improve sports related performance. Further, Industry was not a TD in this product. Though a possible Medical tool, it was seen primarily as a tool used or experienced by a patient or nonprofessional, not a doctor or other worker; hence, the high selection of H&W, the domain defined by its use for "everyday person to promote their health."

On that note, and despite being seen as a product for the everyday person, Lifestyle, the domain defined for "day-to-day tasks," was not a TD in any color version of the product. Like the previous products, Lifestyle was likely to have an inverse selection rate with Medical. In the headband, this could be due to its heavily surmised brain-monitoring function, which is not a common daily experience for the general public. It could also be due to its appearance (e.g. "I've never seen a one-sided device that goes on someone's head). The majority of respondents viewing this product explicitly stated never having seen a product like this before. A product used for the "general day-to-day" would, intuitively, be used by many people and would be recognizable.

What is most noteworthy is how consistent and high the domain selections in Medical and H&W were for this product, given how low the recognition rate was. Guessed domains were also similar to advertised areas. On the Vandrico website, the headband is listed as a Lifestyle product, but as mentioned before, Vandrico does not have a H&W

domain in their database. However, the Thync website describes the product as a mental health and therapy product “used in the consumer health market.” The marketing indicates that the product is to be used by general consumers for wellbeing and stress management, which is in line with the H&W definition. Additionally, despite this marketing, the company’s press releases include published studies on the product’s neurostimulation function as a psoriasis treatment. Therefore, the product also appears to have a Medical target. Still, although many responses assumed the product was related to the brain—as it is—only a handful of individuals described the device as having a stress relief or stimulation function (the actual product functions). Still, responses were close, and explainable: product placement on the body is commonly based on the product’s direct functional relationship to its nearest location (e.g. placement on the chest to measure lung respiration) (Zeagler, 2017). Similarly, devices on the forehead are common to biosensing functions (Zeagler, 2017).

Further, while respondents used body location as a function-cue in the previous products (e.g. “glasses over the face with a device that would most likely enhance vision”), in the headband this was more explicit and there was more variety. The headband wraps from the ear to the forehead, sitting just above the eye. Accordingly, anything from headache relief devices, to hearing aids or headsets, to eye patches were postulated. Such findings bring back questions regarding the AR device and its Top Domains. The AR device, though similar to the smart glasses as eyewear, is also similar to the headband in its higher location on the forehead and coverage on the head. While one of the reasons for the AR’s Medical status was guessed to be due to vision augmentation in comparison to the smart glasses, it is also possible that (similar to the headband) the AR’s Medical, and even S&F, status could be due to assumed brain monitoring—given the head coverage. It is also possible that the AR products’ relative closeness to the ears might have influenced a Communication selection if the domain had been an option at the time of the pilot; Communication was selected for both the headband and the smart glasses.

Of course, the piloted products did not have any descriptive responses to deduce such reasoning from. However, two responses collected for the headband highlighted how respondents took into consideration the interrelationships between many variables—from directly observable features such as body location to more abstract aspects such as social norms—in the interpretation process:

> P1: "The item covers most of the forehead so I assume it has some medical reason for being so conspicuous. It covers a large part of the forehead so metabolism or even some connection to the brain is what I think this item is for."
>
> P2: "Given it is located on such a visible part of the body I am assuming it has to be located in that area despite how it affects one's appearance. This, in my mind, designates this object to be used more as a utility of necessity and most probably related to medical. In human anatomy, the superficial temporal artery protrudes from the top of the ear toward the middle of the forehead at about a 30-degree angle. The black line is nearly on top of where the artery ordinarily would be located. The spearhead of the black object is located in the area where one can typically feel their pulse. I would imagine this may function for someone who may be older....issues related to eye-sight, pressure beneath the skull, or maybe to just simply patch a wound and the fluids flow down toward the backside of the body through a small tube to drain excess fluids."

While such considerations between variables may have been more thought out for the headband, given its low recognition rates and far less common status in the market compared to other wearables—which would push viewers to rely more on perceived product/feature interrelationships (Pinson, 1986)—these thought processes can be applied to all products and support the premise of the apparel-body-construct (DeLong, 1998).

What Wearable Technologies Are Not

There were also some common findings in what these products were *not.* Fashion was not a Top Domain in any of the products in this study, except the pilot tested gesture band, and even then, not in all colors (again, taking into consideration pilot constraints and thus not putting too much emphasis on color). This is consistent with Chuah's (2016) work, which found that wearable technology (smartwatches) were perceived more as a technology than a fashion product. In the current study, the definition given to participants for the Fashion domain was "used for aesthetic purposes." There was consistent support in the descriptive data that the products were seen as tools. While fashion accessories can also be tools or technologies, the Fashion definition focused on the "aesthetic," a word that is commonly synonymous with beauty—which responses indicate is less relevant to tools and to work-related tasks. Though exoskeleton arm supports and AR headgear are not typical fashion items or fashion forms, there are numerous arm bands, head bands, and glasses that are categorized as fashion accessories. Yet almost none of the products in this study were categorized as such. It may be assumed that the products shown to participants (explicitly relayed with certain items, such as the smart glasses) lacked "beautiful" design features; however, beauty is subjective and context dependent. As pointed out in some reviews of the smart glasses, bulkiness indicated that the products were something other than fashionable (e.g. "similar to Google Glass…bulkier and less refined," "an even uglier google glass," and "It isn't fashionable enough to be a consumer product. It looks like something that one uses for their job."). A few responses on the activity monitor also described it as large (e.g. "overly large smartwatch" and "like a large fitbit") and one individual described the headband as "too big." The piloted AR device, relative to common consumer eyewear and hats, is rigid and even larger and more protruding than the glasses or headband. Responses indicated that a fashionable product is expected to have a more refined design. Occupational products, on the other hand, were not. Occupational products must prioritize function and safety over fashion; thus, bulkiness is more acceptable for work tools and garments. As discussed, this connection between size and aesthetics (or lack thereof), being more appropriate or understood for job related or medical required wearables, is consistent with past research (Häkkilä et al, 2015; Nguyen, 2009).

Finally, other domains such as Industry and Military were not selected in many of the products and may be explained by similar reasons above and in previous sections. Further, it is possible that some domain concepts were too abstract, or that the form and its relation to body location was more direct and therefore more influential in perceived function. For example, Safety/Security was only seen as a Top Domain in the smart glasses and AR products. This domain was likely understood as physical safety, such as physical barriers to sensitive body parts (e.g. eyes or brain), or possibly, in reference to the perceived camera/recording function, such as a security camera. More abstract concepts of safety, such as location sharing—found in many wearables marketed towards women or people who travel alone—are internal/digital and thus less perceivable through form factor.

Additionally, one must consider other factors that influence a product's appearance, such as overall shape and material construction. Squared edges, for example, are typical in electronics, and as reported by Silina and Haddadi (2015), wearables that are categorized as gadgets rather than jewelry, are generally made of materials used in electronics (e.g. silicone, utilitarian plastics). Many of the products in this study have a hard-plastic appearance (possibly exacerbated by the Photoshopped color application) which may also have contributed to a tool/gadget, rather than accessory, association. It is plausible that the more gadget-like the materials appear, the more communicated a tool/work functionality becomes. Further, the more a product presents itself as a tool, the more likely observers are to access the concept of "wearable technology" and its most prominent market domains.

Moreover, and most relevant to this study, is that these results indicate that changing the product color did not overpower over variables to make the products more fashionable. However, a product that was more commonly perceived as a fashion product (e.g. the gesture band) could be made to look significantly *less* like a fashion product with a change of color (e.g. green gesture band).

Chapter VI

Conclusion

This study sought to determine whether domain associations are perceived in similar wearable technology products and body placements and whether color would alter domain perceptions if no semantic contextual information about the product was provided to observers. After pilot testing an activity monitor, gesture band, exoskeleton arm support, augmented reality headset, smart glasses, and neurostimulation headband, the activity monitor, smart glasses, and neurostimulation-headband were selected for further study and presented in ten different colors. 1,413 (131 to 151 per product) predominantly White (74%) Millennial age Mechanical Turk Workers reviewed one (color) of each of the three products, and 522 workers answered additional questions to probe their selection answers. T-tests were used to compare the selection counts of domain selections and majority/significant selections were assigned either a High, Mid, Low, or Exception level Top Domain status.

Regarding the influence of color, the results of this study indicated two distinct findings: 1) that color may have influenced domain selections given distinct trends (e.g. alternating relative Top Domain orders, or beige-Medical inclinations) but that results were inconclusive, and 2) regardless, any influence of color was overshadowed by other variables in domain assessment (e.g. product shape, body location, domain to domain relationships, etc.). Specifically, more trends were observed between similar products and similar product locations than were observed between colors.

Findings supported the concept of the apparel-body-construct (DeLong, 1998) and speak to the importance of wearables associations research to supplement or precede social acceptability assessments. Interrelationships between variables (e.g. size and shape and body location) were considered by participants when determining product domains. Further, assumptions about the typicality of the product (given its shape, size, or location, etc.) in certain domains, as well as the potential or possible role of the wearer, were considered. These assumptions and associations provide information about what participants perceive to be normal or acceptable in a given context (e.g. "I am assuming it has to be located in that area despite how it affects one's appearance…designates this object to be used more as a utility of necessity…medical”).

Yet, this study found that even with no semantic product information provided, people were able to assess and often correctly guess the general intended domain of the three products. Within each product there were consistently assumed product areas. For instance, the activity monitor was seen predominantly as a Sports & Fitness, Health & Wellness, Medical, and Lifestyle device; the smart glasses were a Gaming & Entertainment, Industry, Medical, Communication, Military, and Lifestyle product; and the headband was a Medical and Health & Wellness item. Selections closely matched the actual product’s advertised markets.

In addition to consistency was saliency. The count and the different Top Domain levels of selections provide imperative information about the salient assumptions and experience or knowledge of the observers. The High Level Domains and highest majority count domains are the most dominant group shared perceptions. Each product’s HL Top Domains are the most important results to consider for those pursuing group-level (less individual/subjective) perceptions; they are important for those interested in delving deeper into the most-likely-to-encounter opinions formed of, and reactions made to, wearable technologies. The sub-level Top Domains are less common to the group, but often related to (chosen in combination with) HL selections; thus, those interested in individual differences and personal experience should pursue these relationships for further study.

On that note, this study supports Salina and Haddadi’s (2015) findings that multiple domains exist in a single wearable technology product, and contributes to new knowledge by showing that domain relationships change for different products. For example, while Medical and H&W were selected together very frequently in the activity monitor and headband, in the smart glasses this combination was not observed; in the smart glasses, Medical (a HL TD) was selected most frequently with Industry, while H&W was not a Top Domain at all. While this study utilized some pre-grouped domains (e.g. Health & Wellness, Gaming & Entertainment, etc.), it is suggested that in the future, researchers wishing to more closely examine product domains or context associations should reconsider grouping domain areas and instead present single concept options. If groupings are required, the domain relationships for the given product must first be established.

Finally, the observed wearable technology domain and product function associations are not set; associations are subject to temporal and cultural influences (Elliot & Maier, 2012). The results of this study represent a snapshot in time of current knowledge, associations, and assumptions about wearable technologies made by American Millennials. For example, in open-ended responses, the participants named certain brands (e.g. FitBit, Google, Apple) as particularly influential on the recognition of products and knowledge of functions—these are the biggest names *at this time*. If the wearables market continues to increase or change (e.g., market growth or game changer innovations), so too will recognition and experience—and therefore, so too may perception and associations. Further, every new generation who grows up with a technology lacks the pre-existing opinions and associations of older generations; perceptions and associations found in this study are likely to differ from other age groups. Time related effects are especially important to consider for any novel innovations that are expected to differ significantly (whether in function or in form) from what is currently known and understood.

Limitations and Future Research

This study was limited by several factors that may be addressed with further research. First, while Mechanical Turk has been reported to be comparable or better to other convenience sampling methods (Antoun et al., 2016; Necka et al., 2016), convenience samples are not representative of the US population and therefore generalizability of the findings is limited. Future methods should utilize random selection to source a more representative US sample. Further, color blindness should be assessed by a professional, rather than relying on self-reports. This would also dictate that studies be done in person, in a controlled environment (e.g. monitor display settings, etc.) to ensure accurate color presentation and assessment.

There were also limitations to the ways in which the stimuli were presented to participants. The aim of this study was to obtain third party (observer viewpoint) rather than first person (user) perspectives. For this reason, no product information was provided to the participants. However, domains and domain definitions *were* provided; thus, domain assessments were not truly unprompted, as the list may have facilitated function, setting, or user recall. Future work on similar topics may wish to exclude possible categories and have participants enter their own thoughts and definitions. Allowing direct input rather than presenting categories would also avoid any selection exhaustion that may have ensued from filling out a large categorical list. On average, most participants selected three domains, and it is possible that participants simply avoided selecting more possibilities. If categorical questions are to be included, it would be more telling to present each option on a binary Yes-No scale.

Additionally, more explicit definitions relative to specific functions or contexts might be implemented. For example, one limitation was the way in which participants interpreted the categories (observed with the Communication category, and the "recognizable" question). Certain categories may have been too broad or too vague. The Communication option might be broken up into speech or auditory communication, or the ability to send emails, etc. Similarly, "recognition" could be defined as previous experience. Distinctions should be clarified, and such methods would provide more insight into participant perceptions and knowledge.

Furthermore, the specific products used as stimuli consisted of two highly recognized products, and one uncommon/unrecognized product. Although randomized presentation of the stimuli was implemented to buffer some of the inter-stimuli influence, it is possible that the more salient knowledge of the activity monitor and smart glasses influenced the perception of the unknown product. Similarly, the recognition of one product specifically as a "wearable technology" may have directed participants' thoughts towards the most dominant domains in the field (possibly explaining why Medical was a Top Domain in every product), thus affecting perceptions. Likewise, the expectation of what certain products would look like based on the recognition-references clearly influenced perceptions (e.g. "a bulkier" version of Google Glass," "recolored Google Glass," etc.) and may have caused reference-similar or reference-dissimilar domain selections. Possible methods for either circumventing such issues or more clearly identifying such influences might include studying a singular product or a single product category (in function, shape, color, etc.), or studying products with a similar degree of recognizability, and including more directed questions on reference reasoning. In-person interviews would also be invaluable, as such methods allow for response probing.

Correspondingly, while this study presented stimuli on a mannequin to divorce the product from other contextual influences, such as skin color, or environment, etc.—context does matter and will influence how the product and wearer are perceived (DeLong, 1998).

Future work may wish to concentrate on whether and how domain selections of the products change if on different wearers (e.g. different genders, ages, social or professional roles; styles of clothing, etc.) or in different settings (e.g. hospitals vs coffee shops, etc.).

Similarly, there is a myriad of other attributes (e.g. odor, price, weight, etc.) that might influence general product assessment (Pinson, 1986). In regard to wearable technology, and domain evaluation specifically, certain additional features should be given initial attention in future research. Given the comments made by the participants in the open-ended responses, product size and bulkiness should be studied extensively to determine the effect strength on domain assessment. Material and shape/contour are other potential features to examine, as detailed in the results discussion. Determining whether and how any other possible features influence domain perception would require additional research.

Finally, more work is needed to assess color associations. There were suggestions of color associations in the study results, but conclusions were limited by the study methods. In this study, each product-color was presented to a different group of participants to reduce product and color overexposure. Resulting domain selections were highly consistent across all colors of a single product (suggesting no color influence), but the order and significance between the same resulting Top Domains varied from color to color—suggesting *some* influence of color. However, because associations can be subjective and based on personal knowledge and experience (Elliot & Maier, 2012; Klein, 2018), and each colored-product was reviewed by a different participant group, it was unclear whether color, or participant variance, was the reason for these slight Top Domain order findings. Moving forward, further work assessing color associations should aim to recruit a more homogenous participant group.

In a similar vein, frequency counts suggested that color might have a moderating effect (strengthening or weakening, rather than direct cause and effect) on individual domain-product associations. For example, in the beige headband, Medical had an 85% selection rate, but in the green headband, Medical had a 65% selection rate. Yet, statistical tests showed that significant differences ($p<0.00007$) between these colors were not observed—which would indicate, again, no influence of color. However, the statistical measures used may have been too strict for the purposes of this more exploratory study. In this study, the Bonferroni Correction was applied to prevent a Type I error (false positive) from occurring when numerous comparisons are run. The Bonferroni changes the level at which significance can be concluded. One risk in applying a correction as stringent as the Bonferroni Correction, however, is that Type II errors (false negatives) can become more likely when strict measures are put in place to reduce Type I errors (Perneger, 1998). Prior to applying to the Bonferroni Correction, several low p-values were observed (see Appendix I for these results). Thus, it is possible that true differences were ignored. Additional research on those low p-value color to color comparisons is worth pursuing in future research. The author suggests future work on the color congruency or moderating effect of color on product-domain associations. For example, researchers might test whether a relationship exists between certain colors and the speed of domain selection. Highly congruent colors are said to increase the speed of product recognition (see Bramão, Reis, Petersson, & Faísca, 2011); a swifter domain selection in specific colors would imply higher color-domain congruency and thus association.

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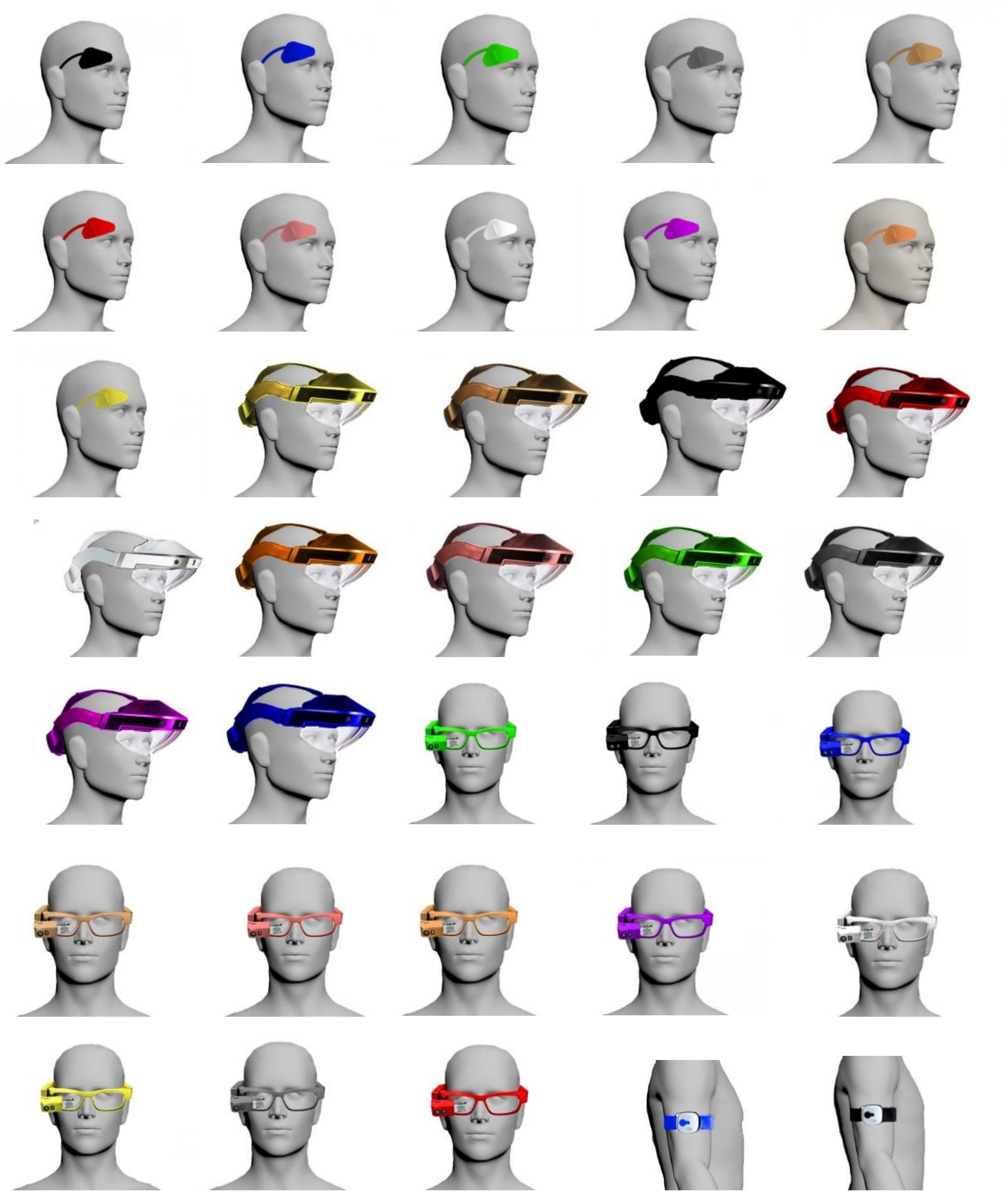
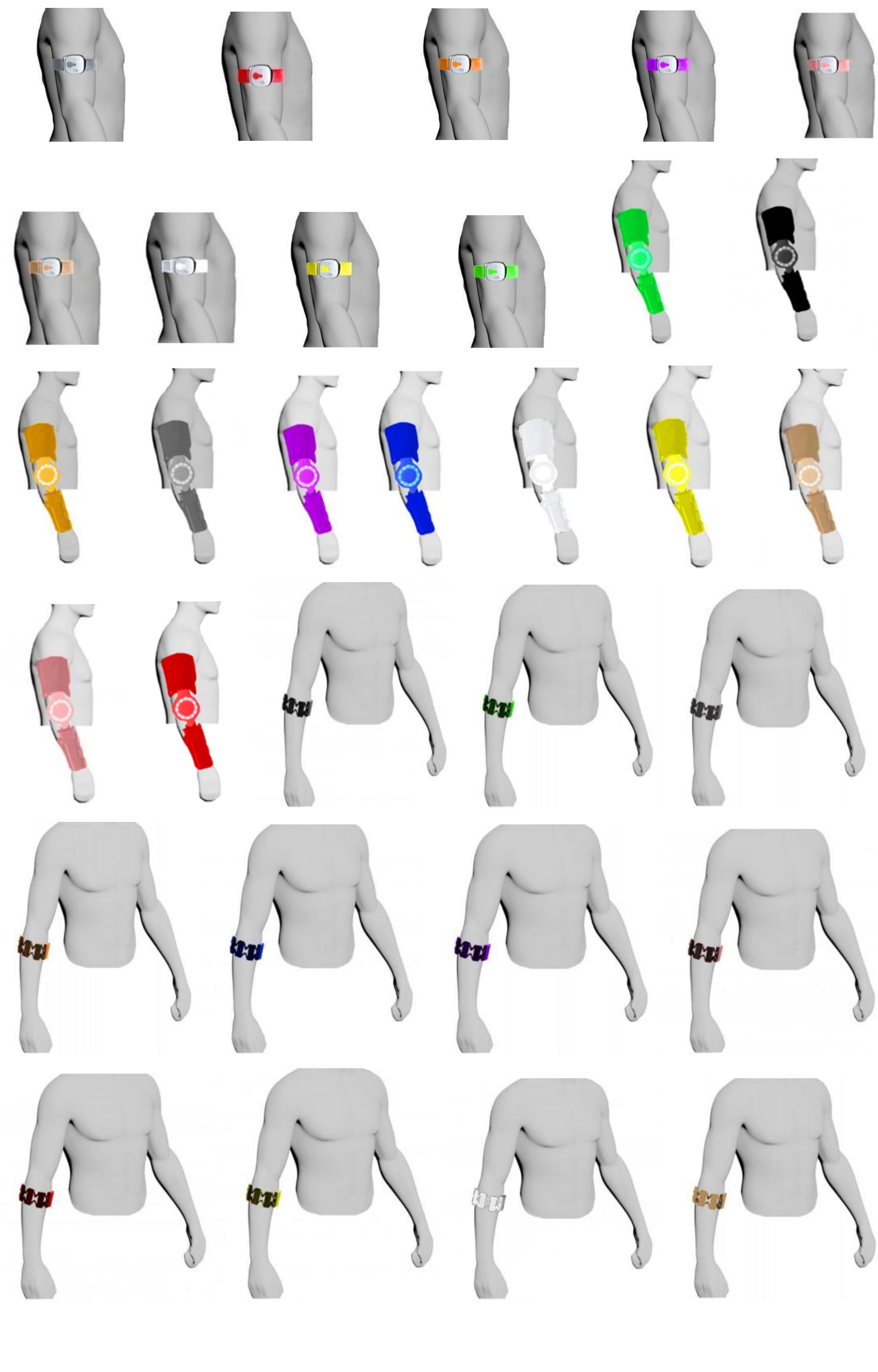
Appendix A

Pilot Study Survey Images





Appendix B

Pilot Survey

What is your gender?

Male

Female

Transgender Male

Transgender Female

Nonbinary

Prefer not to say

What is your age?

▼

DIRECTIONS: In the following sections you will review 7 products. After reviewing each product, please select the area/domain you think the item ***most*** likely belongs to. You will not be given any description of what the product is, and should make your best guess based on the image you are shown.

Attention Check: **There will be 1 attention check in this survey, with explicit directions in the question. Please read each question before you select your response.**

[IMAGE]

Please select the area that you think this item *most* likely belongs to.

(you may select more than one)

Industry (used by someone to perform their job, usually in the production of goods or services)

Military (used by military personnel for the purposes of training or combat)

Sports/Fitness (used to assist in the performance of athletic activities)

Lifestyle (used for general, day-to-day tasks)

Gaming & Entertainment (used for recreational and entertainment purposes)

Health & Wellness (used by an everyday person to promote their health)

Fashion (used for aesthetic purposes)

Medical (used by doctors or patients for medical reasons)

Security/Safety (used for protection)

Other, please specify

[Repeat x6 products]

[IMAGE]

To show you are paying attention, please select the choice "Lifestyle"

Industry (used by someone to perform their job, usually in the production of goods or services)

Military (used by military personnel for the purposes of training or combat)

Sports/Fitness (used to assist in the performance of athletic activities)

Lifestyle (used for general, day-to-day tasks)

Gaming & Entertainment (used for recreational and entertainment purposes)

Health & Wellness (used by an everyday person to promote their health)

Fashion (used for aesthetic purposes)

Medical (used by doctors or patients for medical reasons)

Security/Safety (used for protection)

Other, please specify ____________

Appendix C

Pilot 2 (Not Pursued) Survey Results

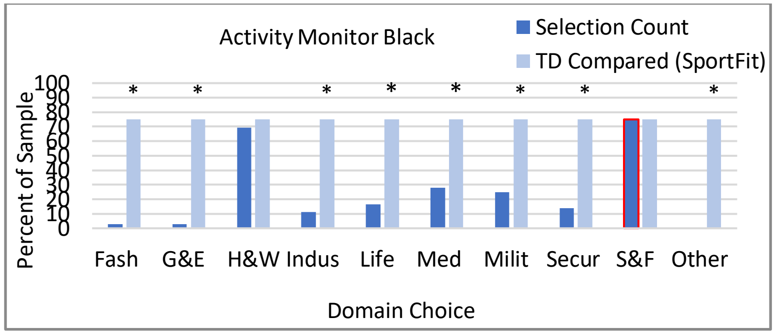


Figure C1. Domain comparison Activity Monitor Black (sample size n=36)

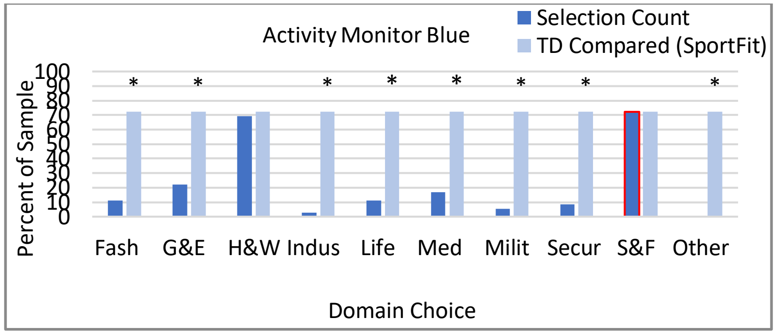


Figure C2. Domain comparison Activity Monitor Blue (sample size n=36)

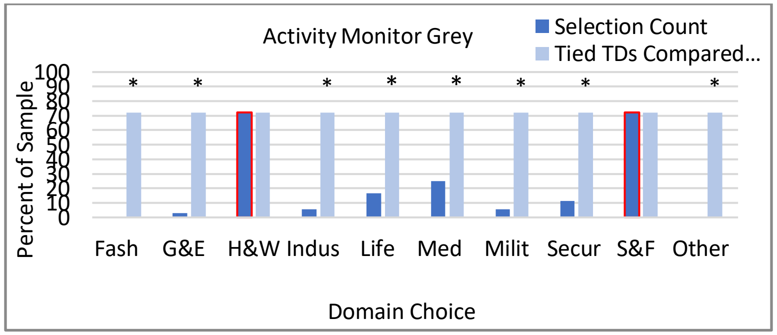


Figure C3. Domain comparison Activity Monitor Grey (sample size n=36)

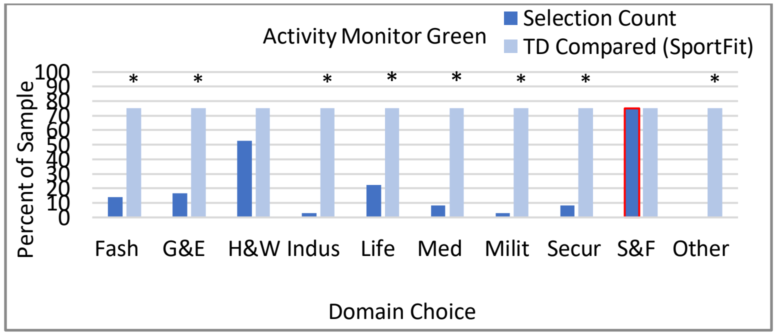


Figure C4. Domain comparison Activity Monitor Green (sample size n=36)

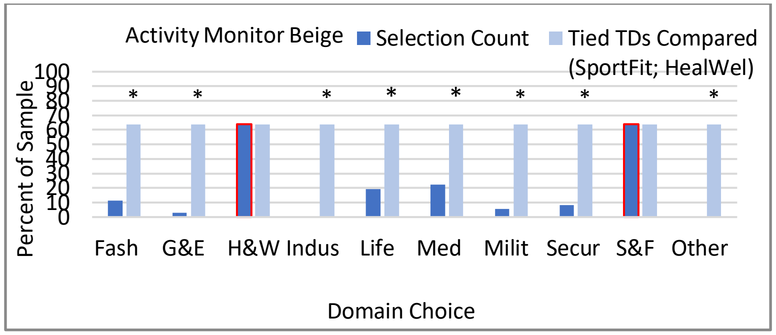


Figure C5. Domain comparison Activity Monitor Beige (sample size n=36)

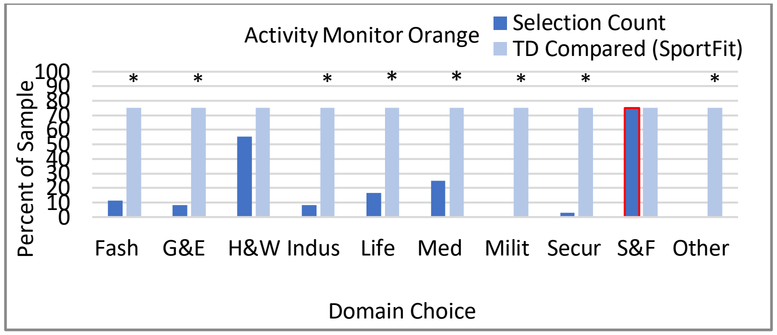


Figure C6. Domain comparison Activity Monitor Orange (sample size n=36)

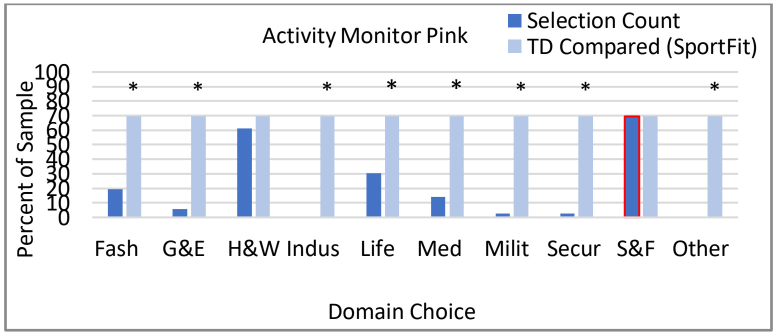


Figure C7. Domain comparison Activity Monitor Pink (sample size n=36)

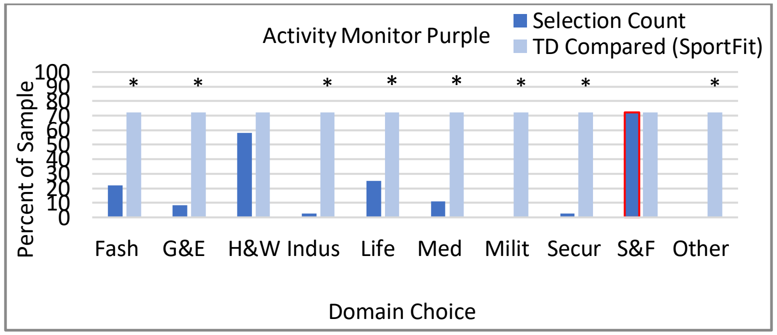


Figure C8. Domain comparison Activity Monitor Purple (sample size n=36)

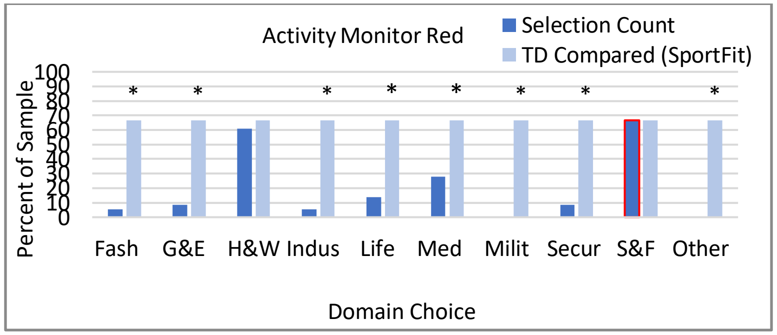


Figure C9. Domain comparison Activity Monitor Red (sample size n=36)

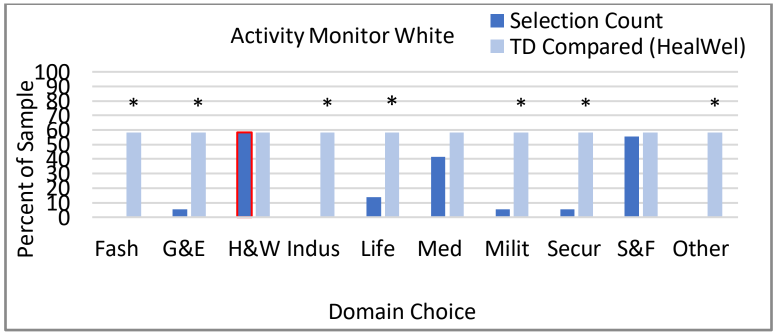


Figure C10. Domain comparison Activity Monitor White (sample size n=36)

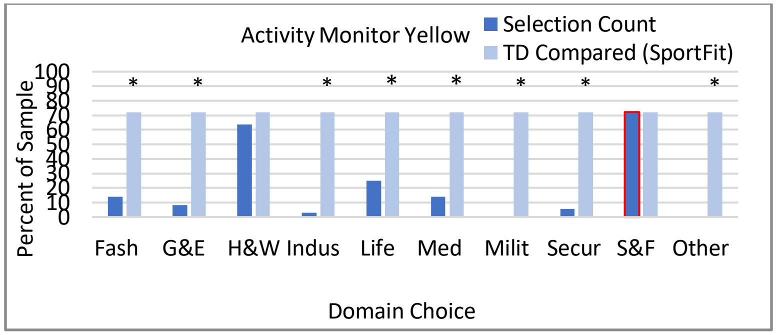


Figure C11. Domain comparison Activity Monitor Yellow (sample size n=36)

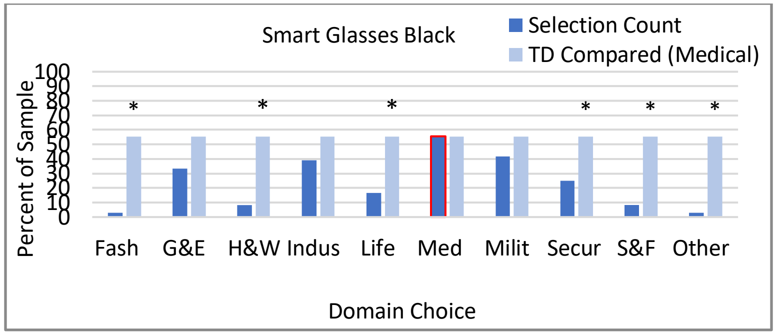


Figure C12. Domain comparison Smart Glasses Black (sample size n=36)

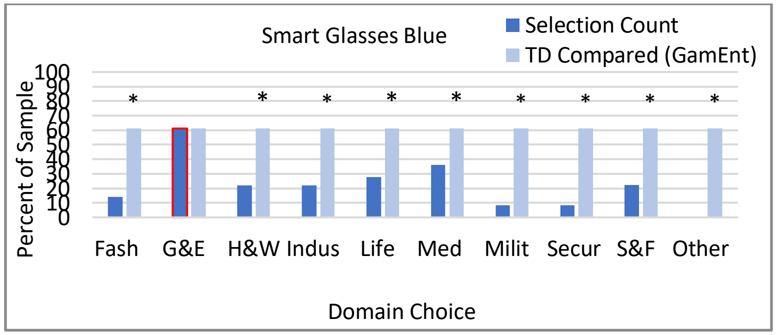


Figure C13. Domain comparison Smart Glasses Blue (sample size n=36)

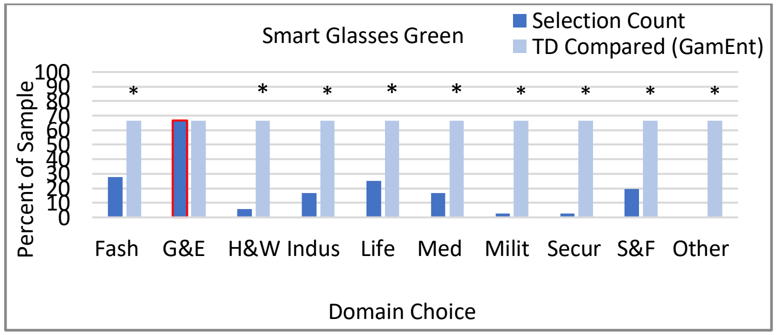


Figure C14. Domain comparison Smart Glasses Green (sample size n=36)

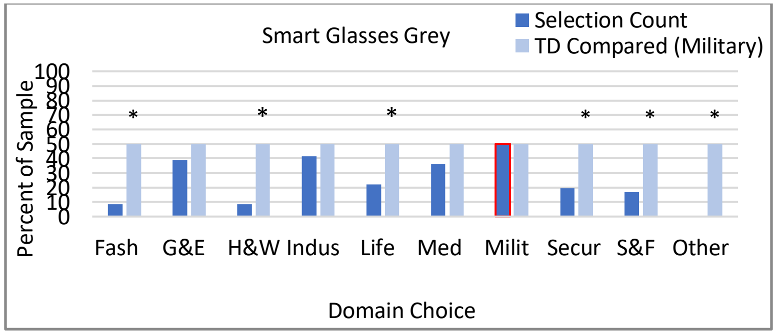


Figure C15. Domain comparison Smart Glasses Grey (sample size n=36)

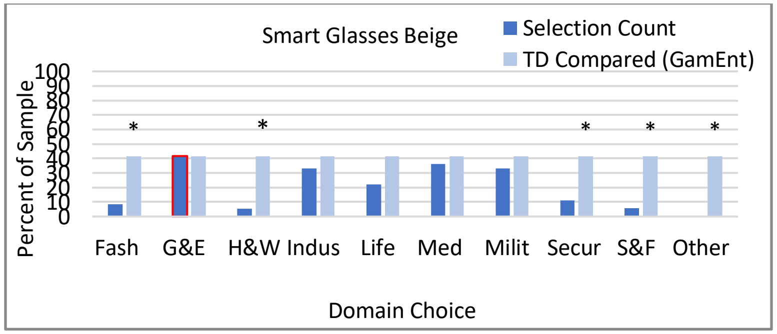


Figure C16. Domain comparison Smart Glasses Beige (sample size n=36)

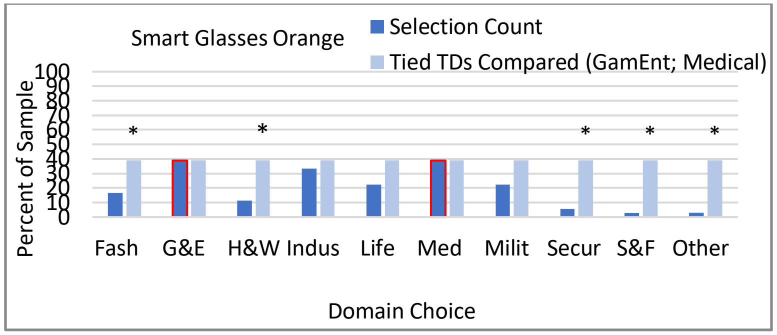


Figure C17. Domain comparison Smart Glasses Orange (sample size n=36)

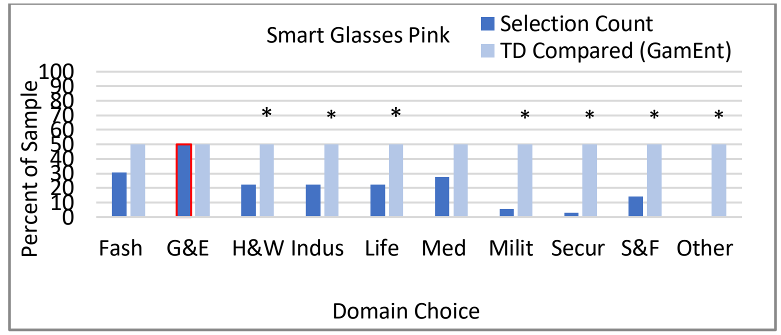


Figure C18. Domain comparison Smart Glasses Pink (sample size n=36)

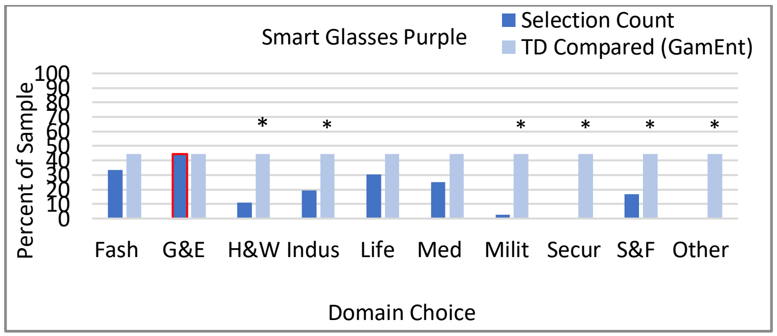


Figure C19. Domain comparison Smart Glasses Purple (sample size n=36)

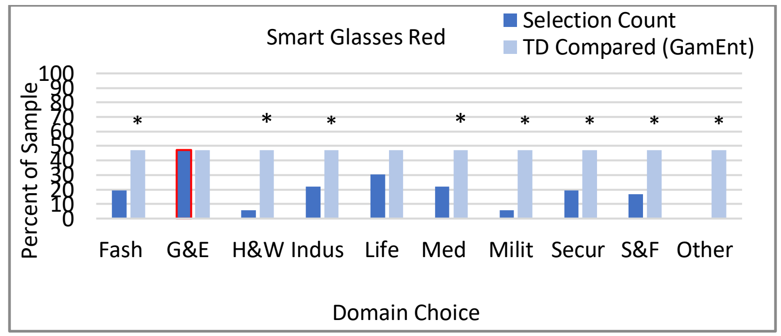


Figure C20. Domain comparison Smart Glasses Red (sample size n=36)

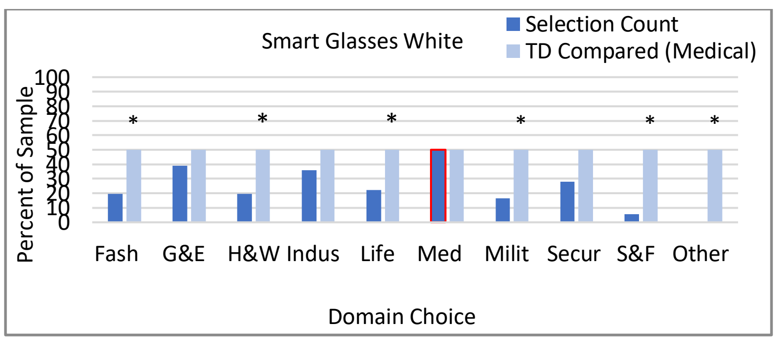


Figure C21. Domain comparison Smart Glasses White (sample size n=36)

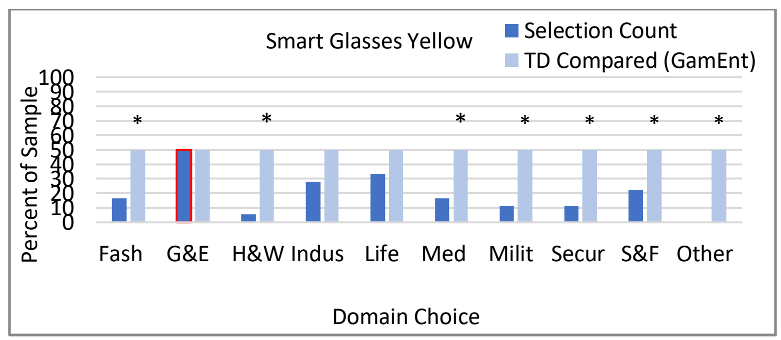


Figure C22. Domain comparison Smart Glasses Yellow (sample size n=36)

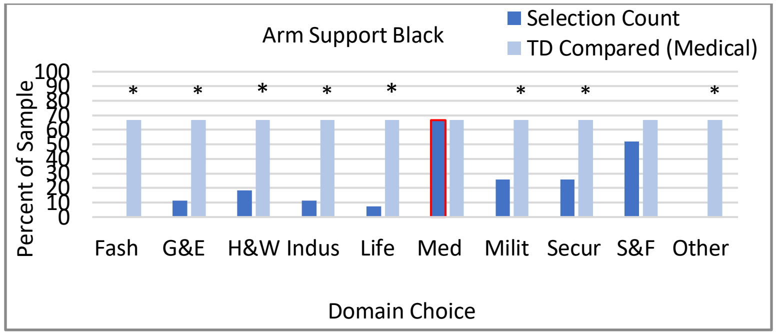


Figure C23. Domain comparison Arm Support Black (sample size p=27)

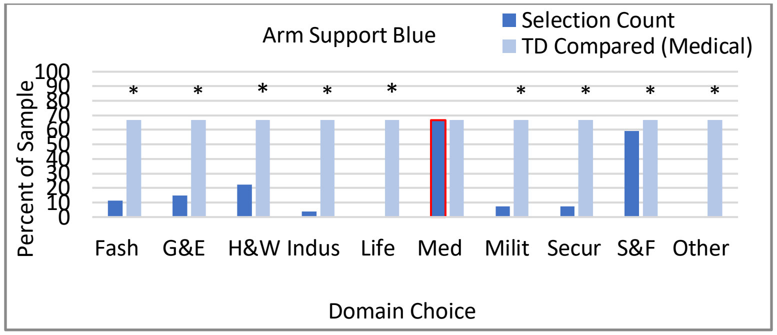


Figure C24. Domain comparison Arm Support Blue (sample size p=27)

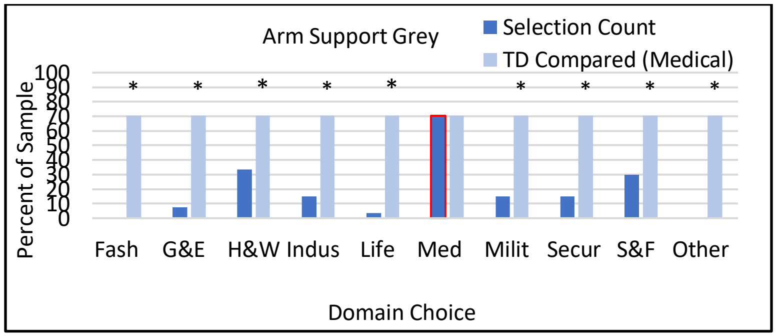


Figure C25. Domain comparison Arm Support Grey (sample size p=27)

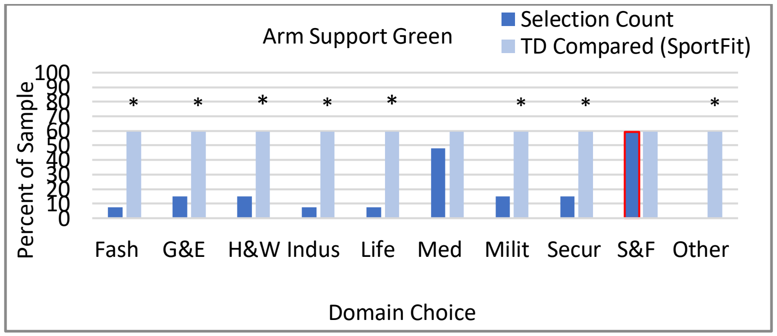


Figure C26. Domain comparison Arm Support Green (sample size p=27)

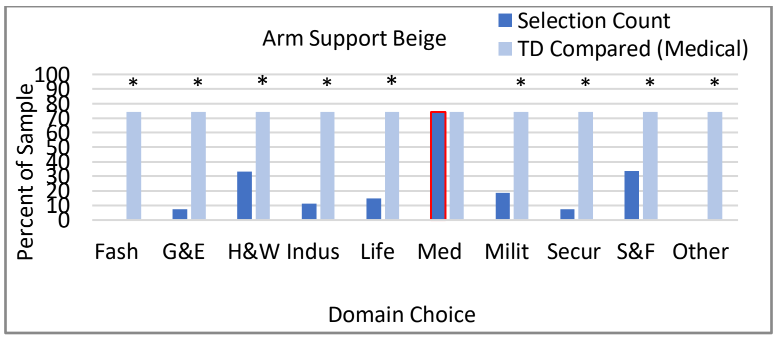


Figure C27. Domain comparison Arm Support Beige (sample size p=27)

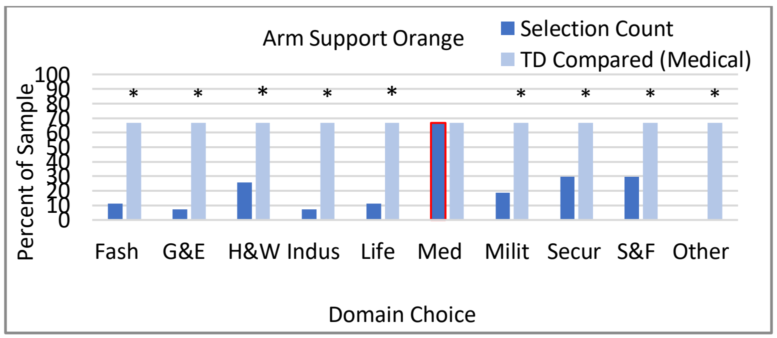


Figure C28. Domain comparison Arm Support Orange (sample size p=27)

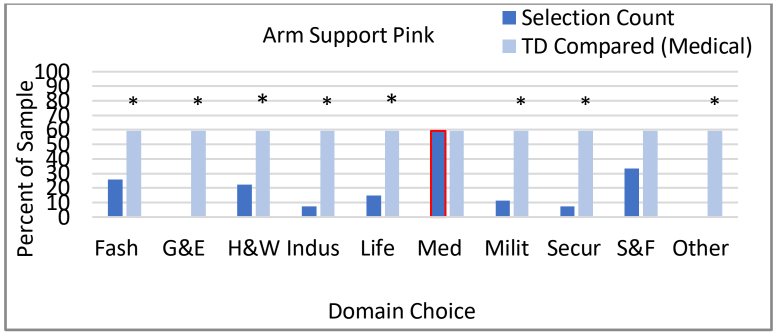


Figure C29. Domain comparison Arm Support Pink (sample size p=27)

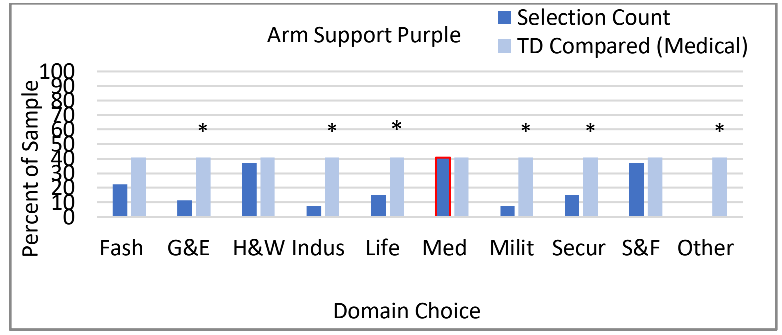


Figure C30. Domain comparison Arm Support Purple (sample size p=27)

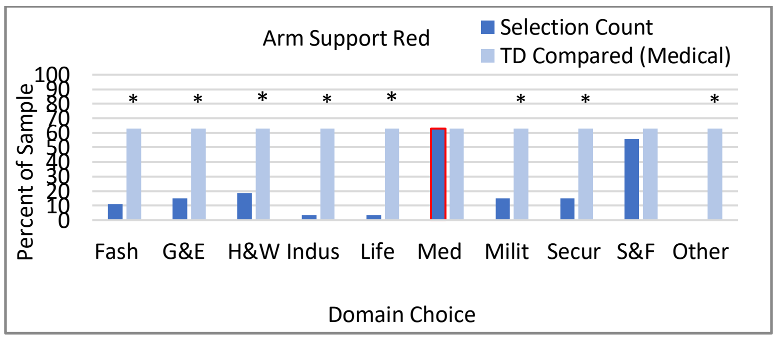


Figure C31. Domain comparison Arm Support Red (sample size p=27)

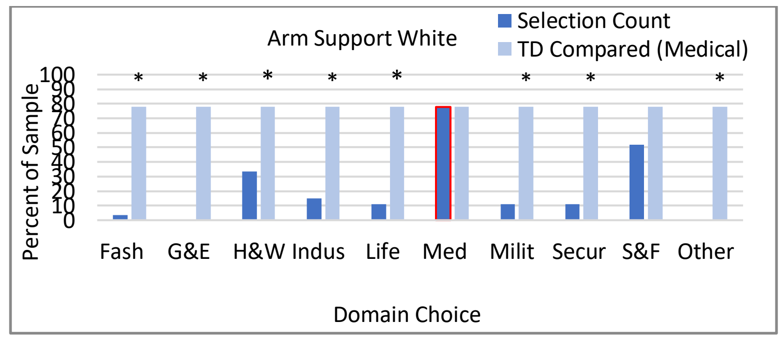


Figure C32. Domain comparison Arm Support White (sample size p=27)

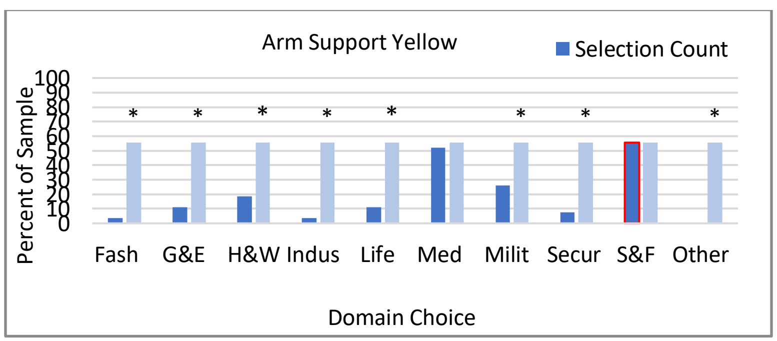


Figure C33. Domain comparison Arm Support Yellow (sample size p=27)

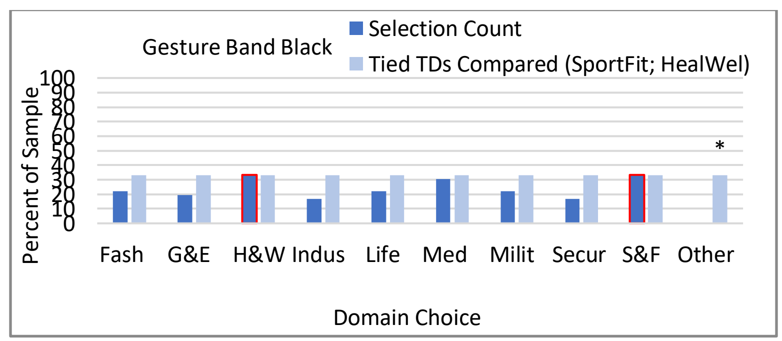


Figure C34. Domain comparison Gesture Band Black (sample size n=36)

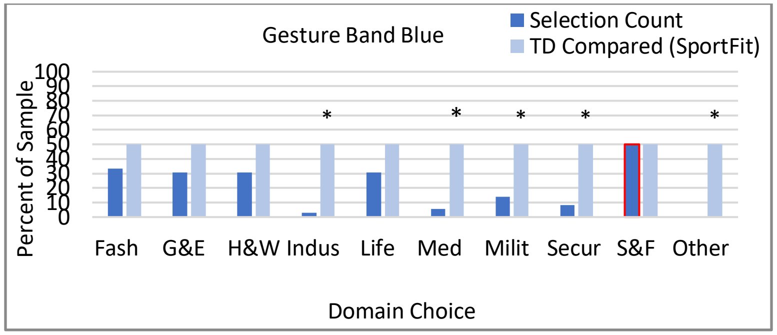


Figure C35. Domain comparison Gesture Band Blue (sample size n=36)

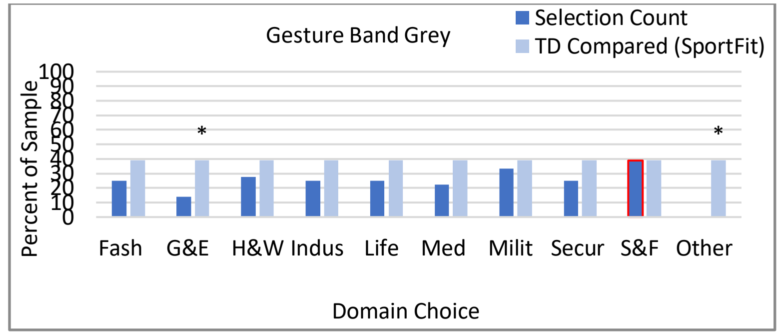


Figure C36. Domain comparison Gesture Band Grey (sample size n=36)

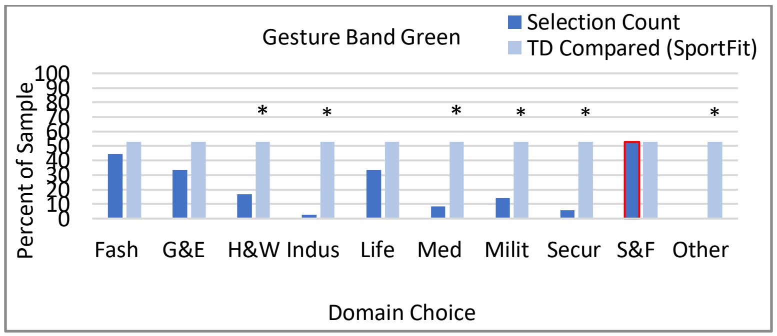


Figure C37. Domain comparison Gesture Band Green (sample size n=36)

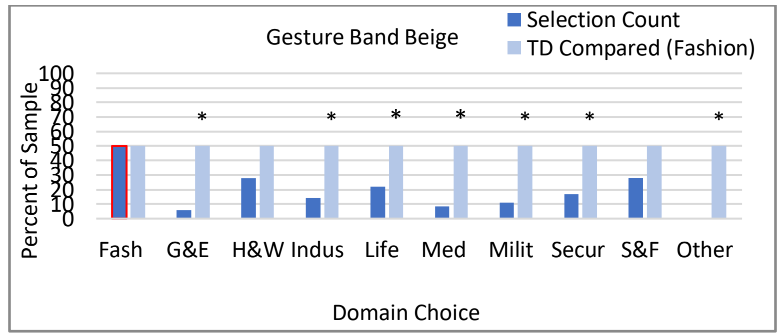


Figure C38. Domain comparison Gesture Band Beige (sample size n=36)

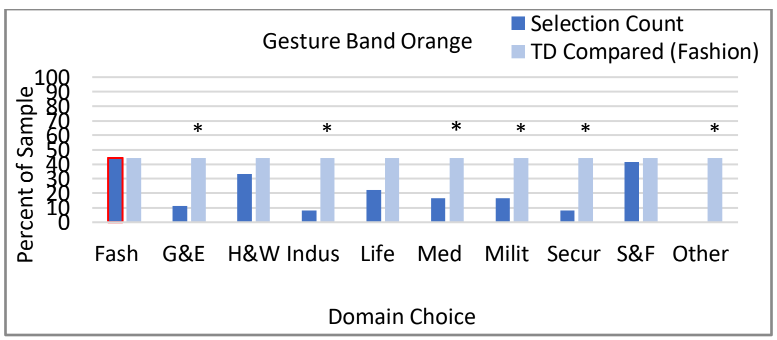


Figure C39. Domain comparison Gesture Band Orange (sample size n=36)

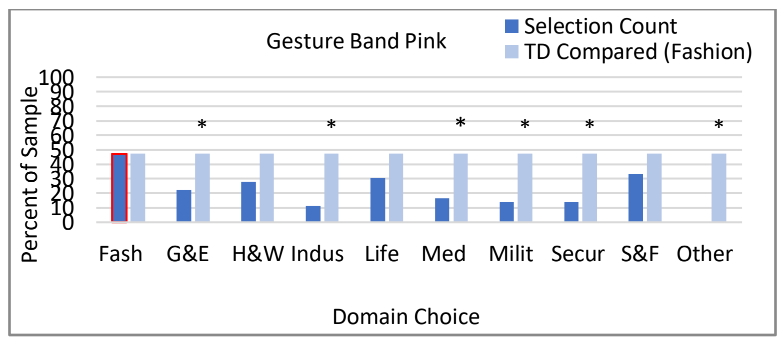


Figure C40. Domain comparison Gesture Band Pink (sample size n=36)

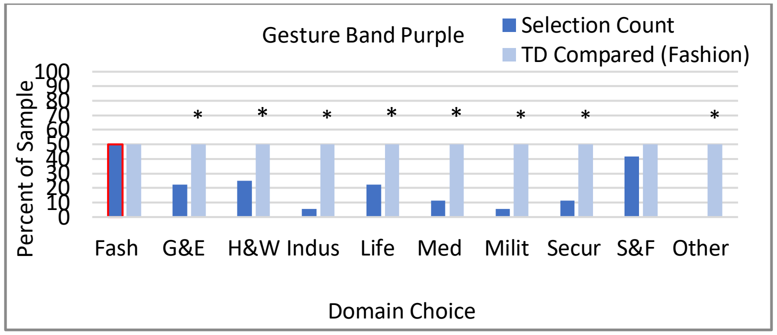


Figure C41. Domain comparison Gesture Band Purple (sample size n=36)

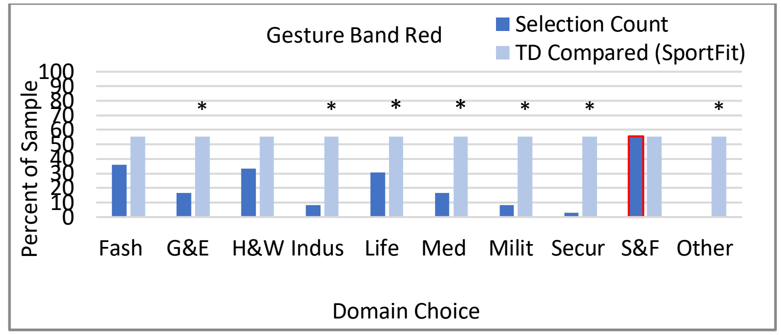


Figure C42. Domain comparison Gesture Band Red (sample size n=36)

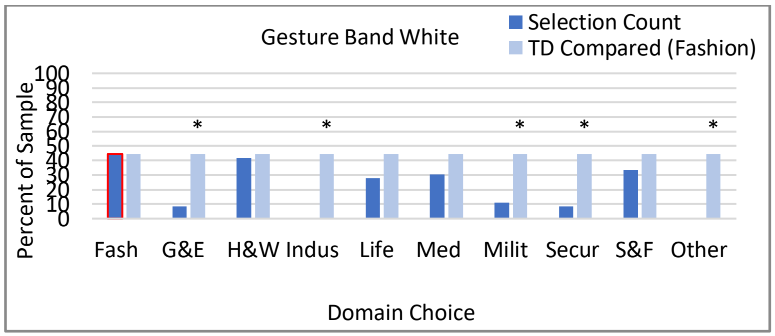


Figure C43. Domain comparison Gesture Band White (sample size n=36)

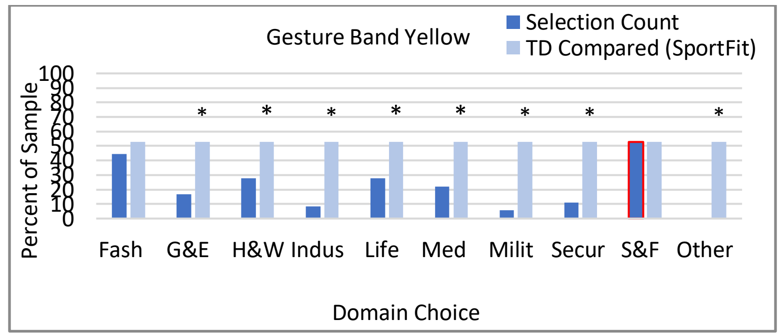


Figure C44. Domain comparison Gesture Band Yellow (sample size n=36)

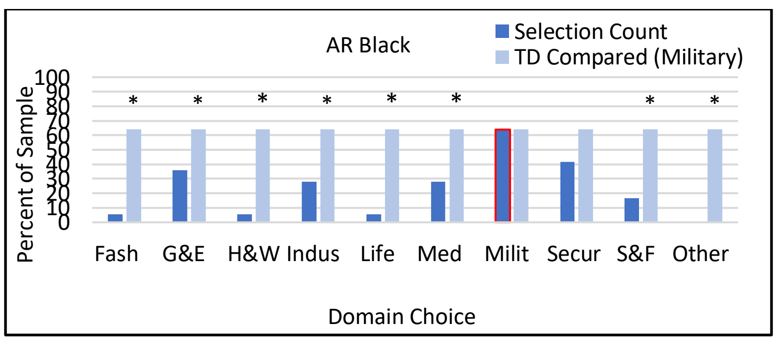


Figure C45. Domain comparison AR Black (sample size n=36)

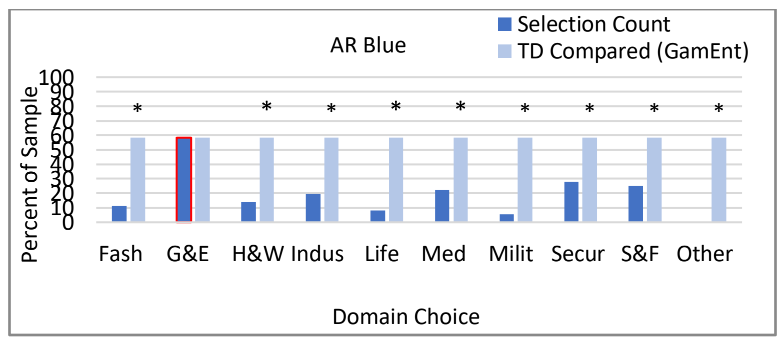


Figure C46. Domain comparison AR Blue (sample size n=36)

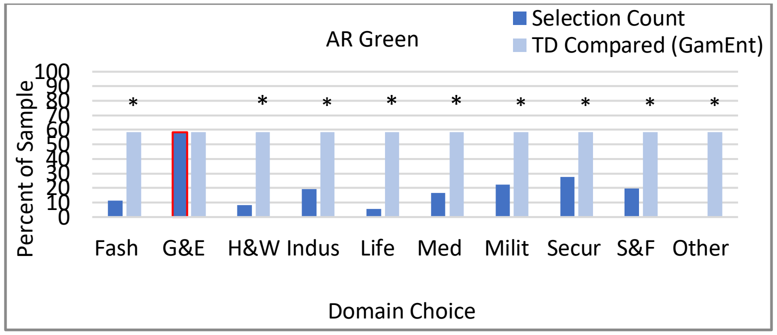


Figure C47. Domain comparison AR Green (sample size n=36)

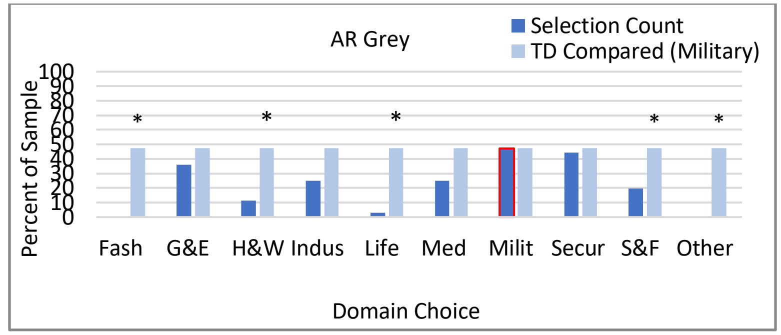


Figure C48. Domain comparison AR Grey (sample size n=36)

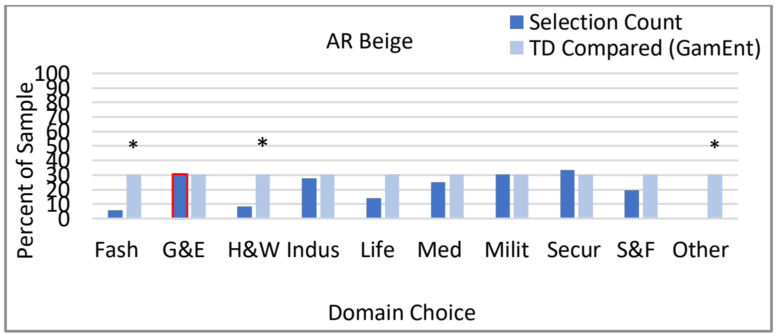


Figure C49. Domain comparison AR Beige (sample size n=36)

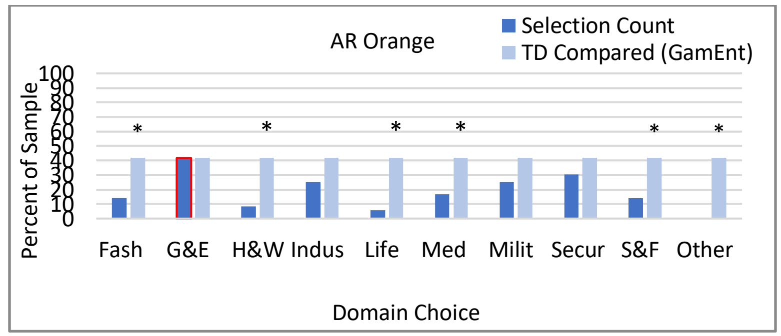


Figure C50. Domain comparison AR Orange (sample size n=36)

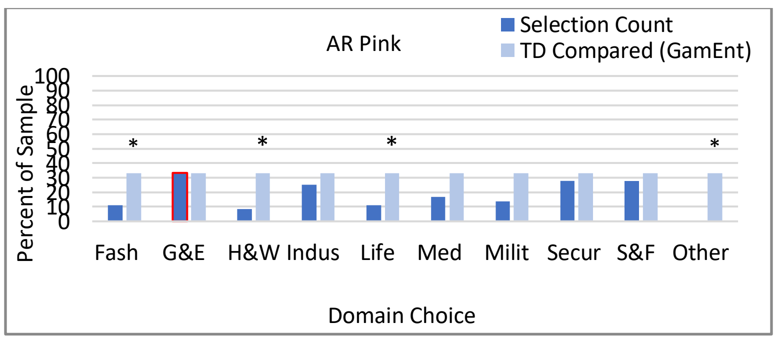


Figure C51. Domain comparison AR Pink (sample size n=36)

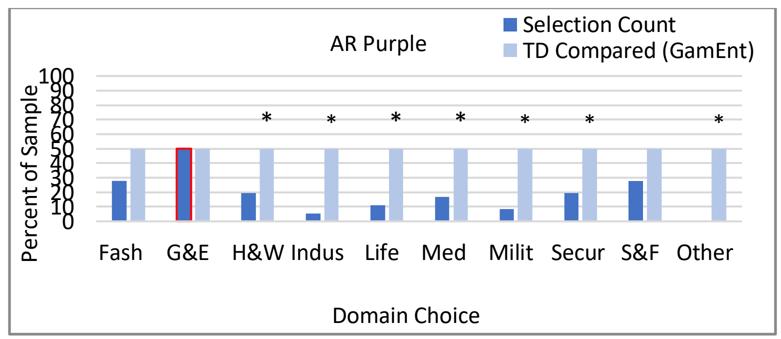


Figure C52. Domain comparison AR Purple (sample size n=36)

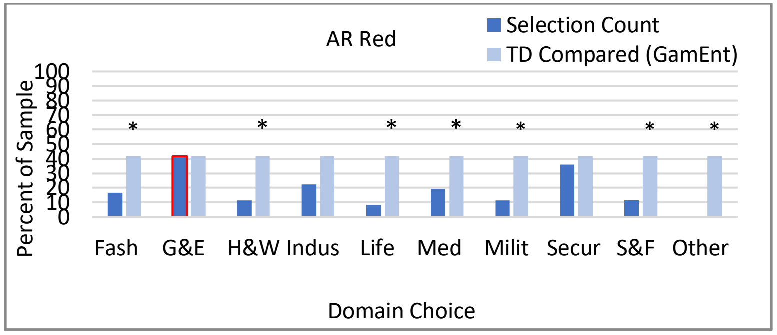


Figure C53. Domain comparison AR Red (sample size n=36)

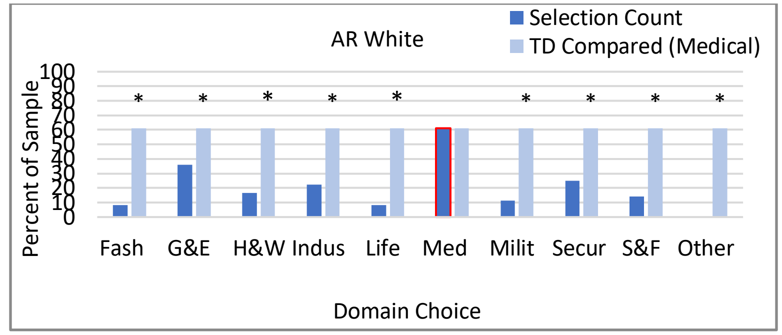


Figure C54. Domain comparison AR White (sample size n=36)

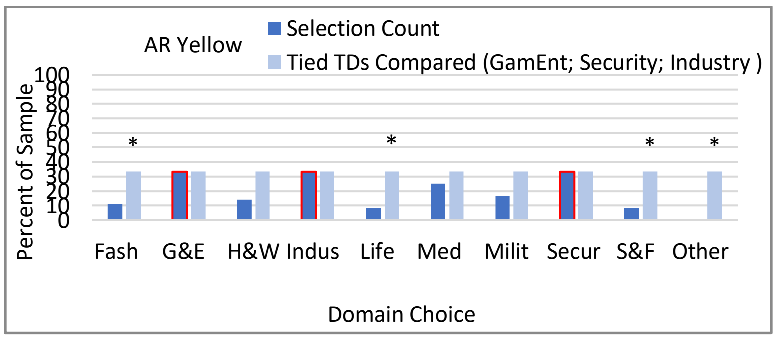


Figure C55. Domain comparison AR Yellow (sample size n=36)

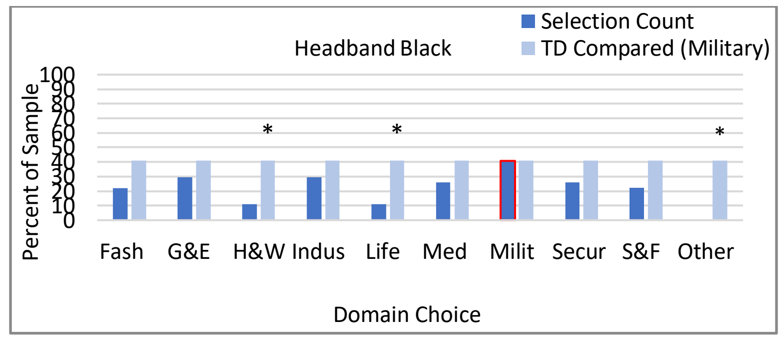


Figure C56. Domain comparison Headband Black (sample size n=27)

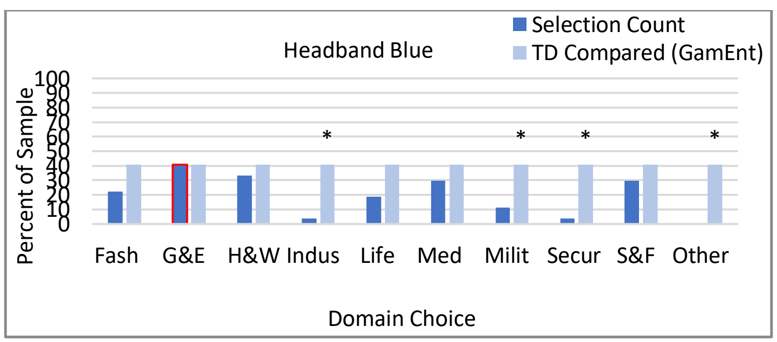


Figure C57. Domain comparison Headband Blue (sample size n=27)

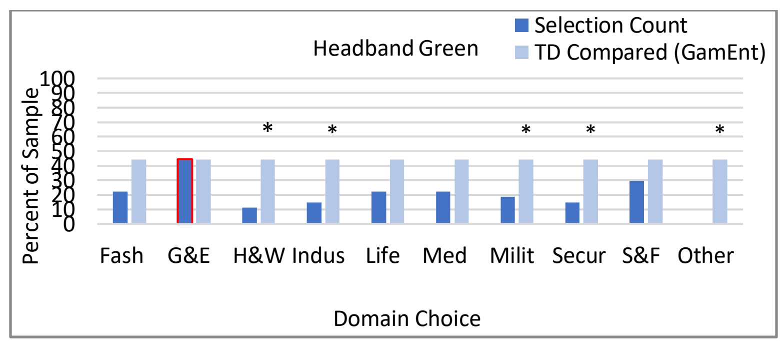


Figure C58. Domain comparison Headband Green (sample size n=27)

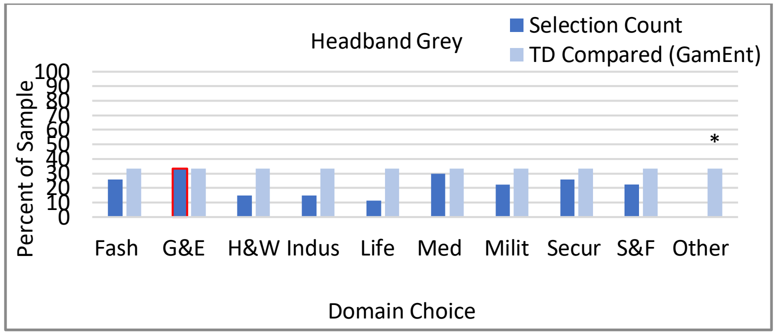


Figure C59. Domain comparison Headband Grey (sample size n=27)

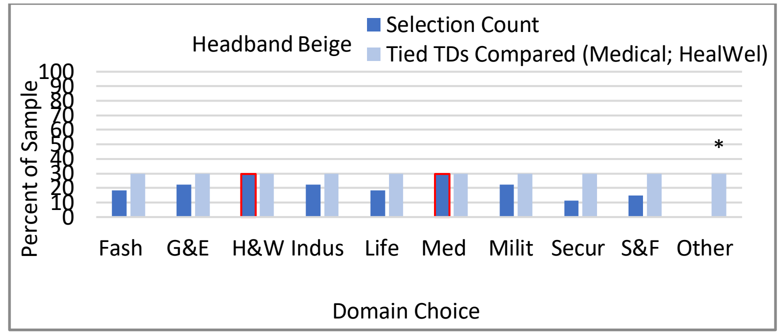


Figure C60. Domain comparison Headband Beige (sample size n=27)

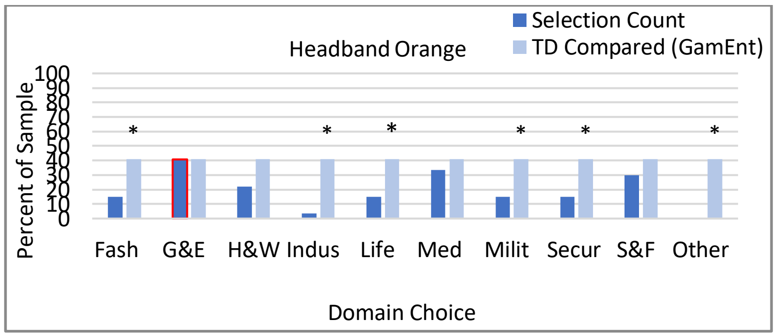


Figure C61. Domain comparison Headband Orange (sample size n=27)

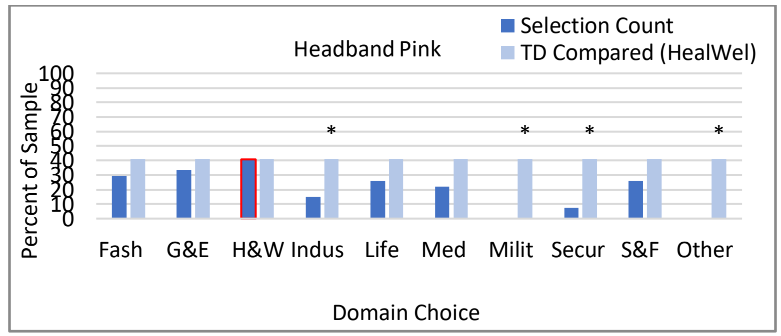


Figure C62. Domain comparison Headband Pink (sample size n=27)

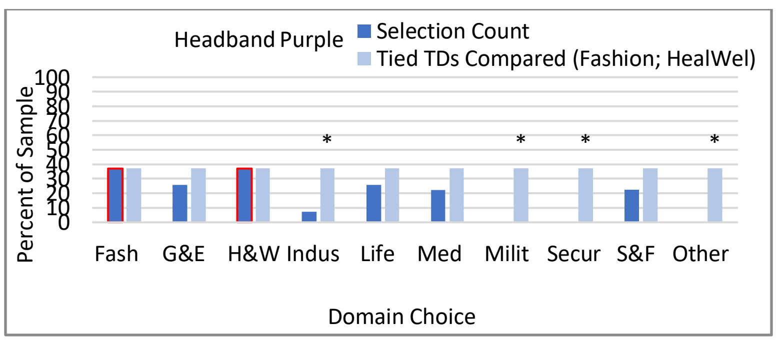


Figure C63. Domain comparison Headband Purple (sample size n=27)

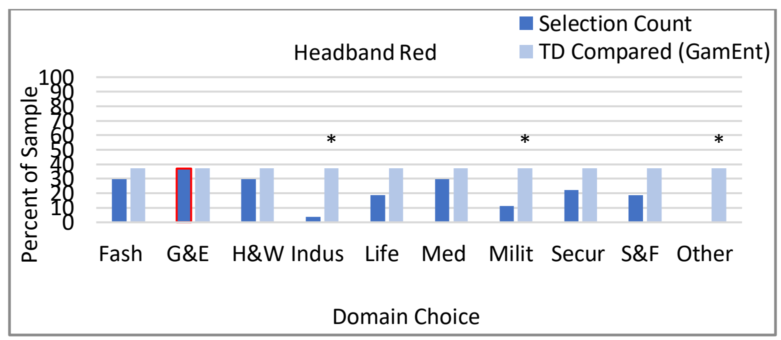


Figure C64. Domain comparison Headband Red (sample size n=27)

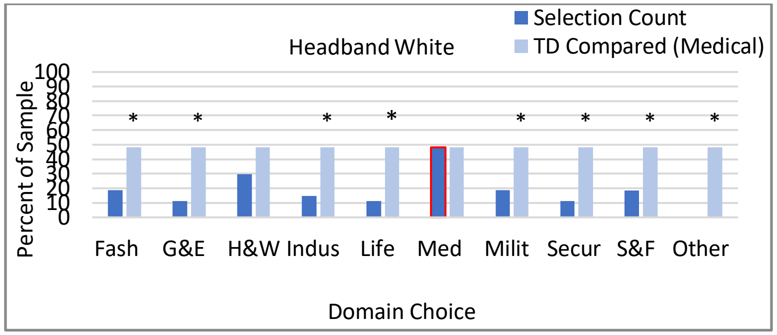


Figure C65. Domain comparison Headband White (sample size n=27)

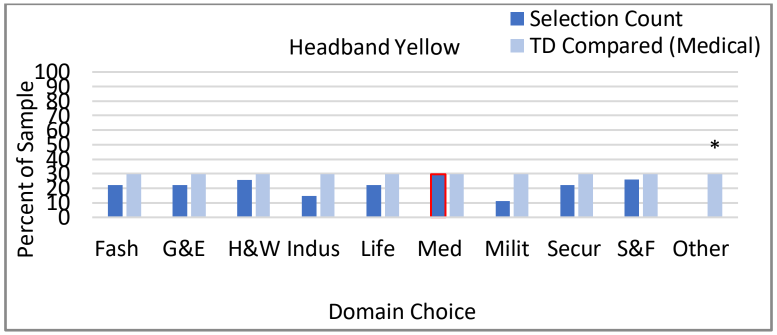


Figure C66. Domain comparison Headband Yellow (sample size n=2)

Appendix D

Pilot 1 Survey Results

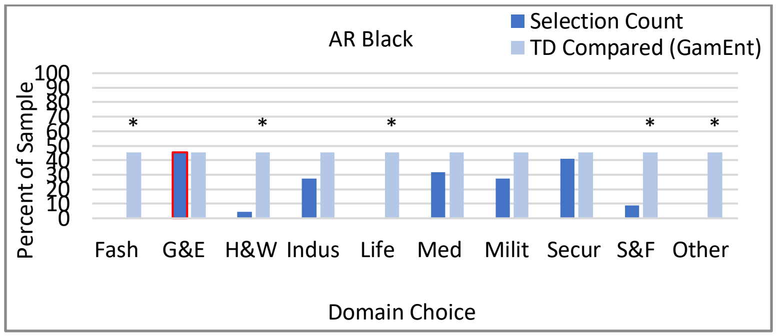


Figure D1. Domain comparison AR Black (sample size n=22)

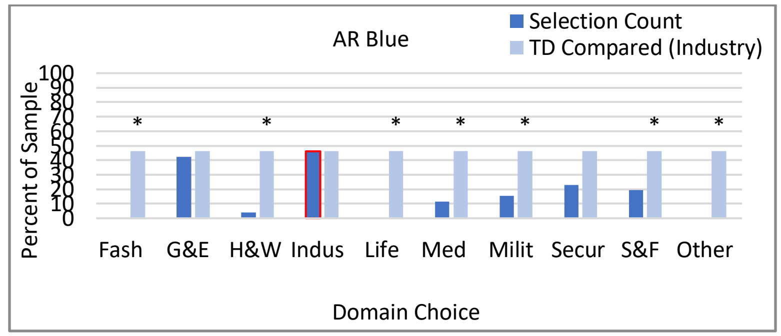


Figure D2. Domain comparison AR Blue (sample size n=26)

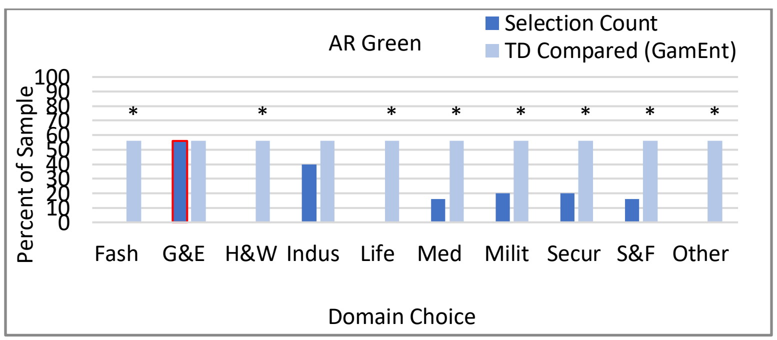


Figure D3. Domain comparison AR Green (sample size n=26)

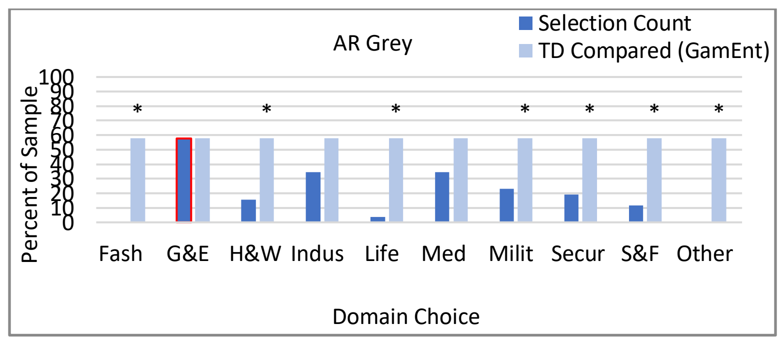


Figure D4. Domain comparison AR Grey (sample size n=25)

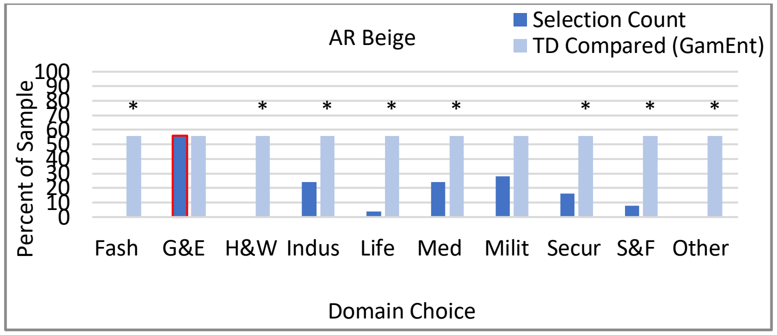


Figure D5. Domain comparison AR Beige (sample size n=25)

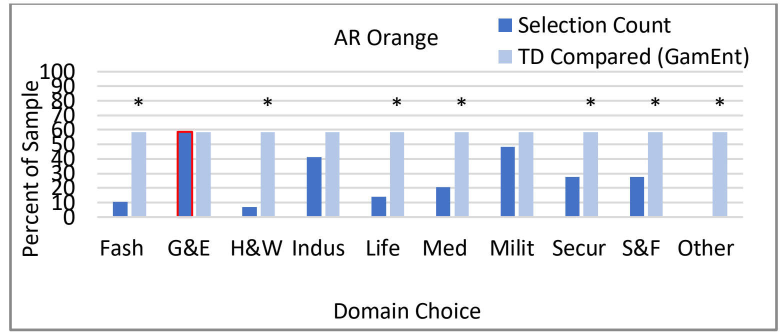


Figure D6. Domain comparison AR Orange (sample size n=29)

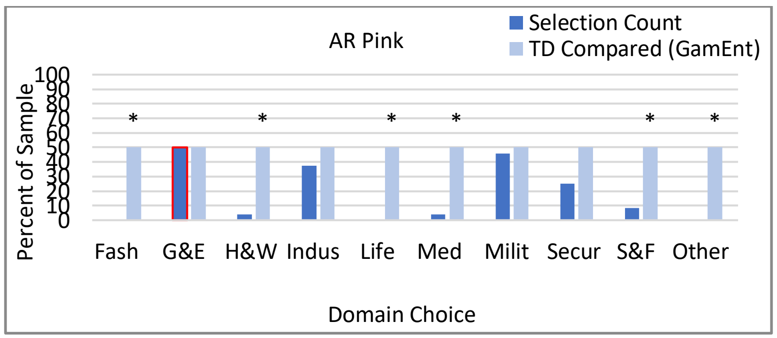


Figure D7. Domain comparison AR Pink (sample size n=24)

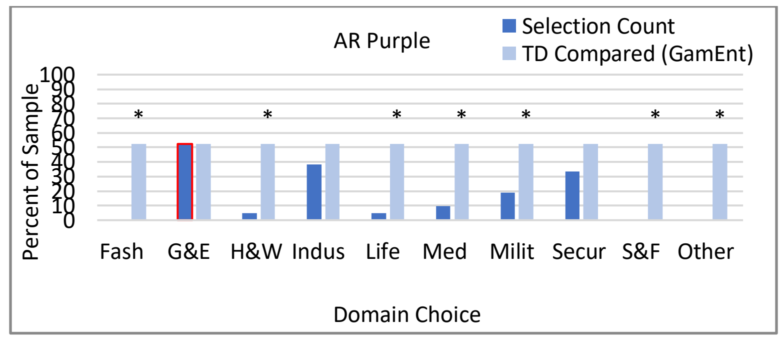


Figure D8. Domain comparison AR Purple (sample size n=21)

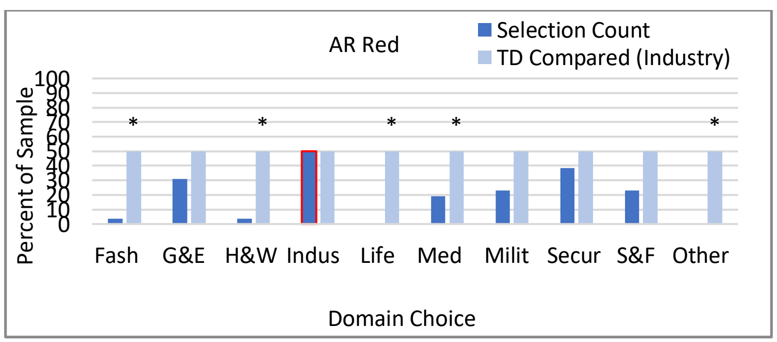


Figure D9. Domain comparison AR Red (sample size n=26)

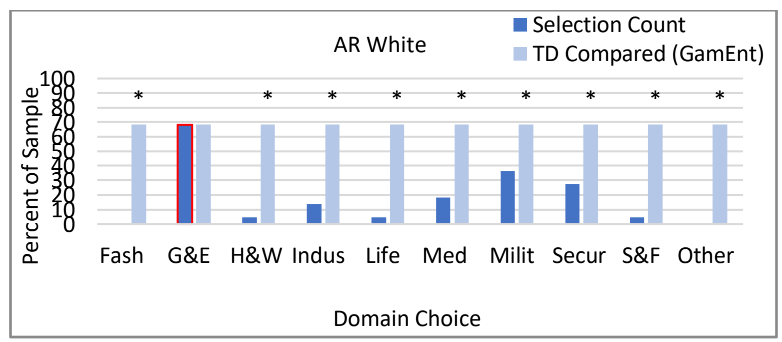


Figure D10. Domain comparison AR White (sample size n=22)

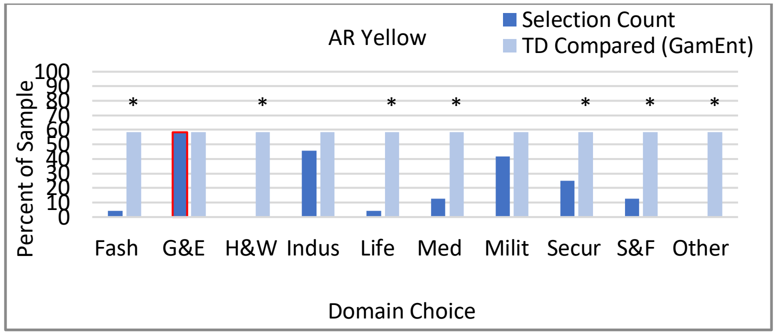


Figure D11. Domain comparison AR Yellow (sample size n=24)

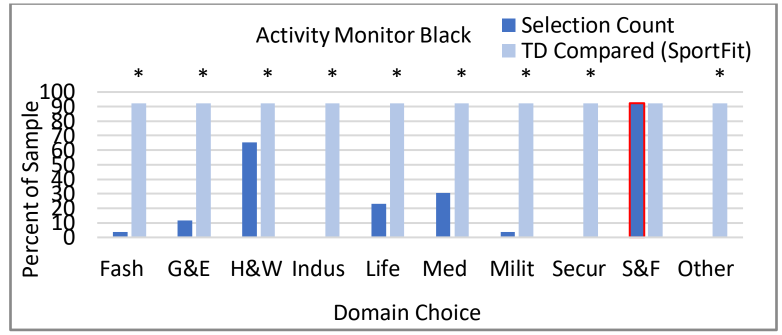


Figure D12. Domain comparison Activity Monitor Black (sample size n=26)

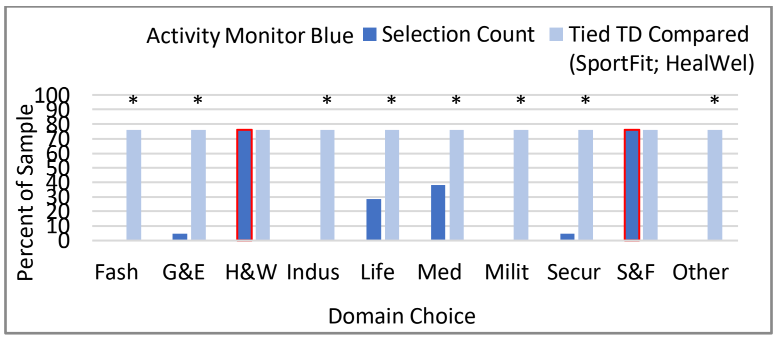


Figure D13. Domain comparison Activity Monitor Blue (sample size n=21)

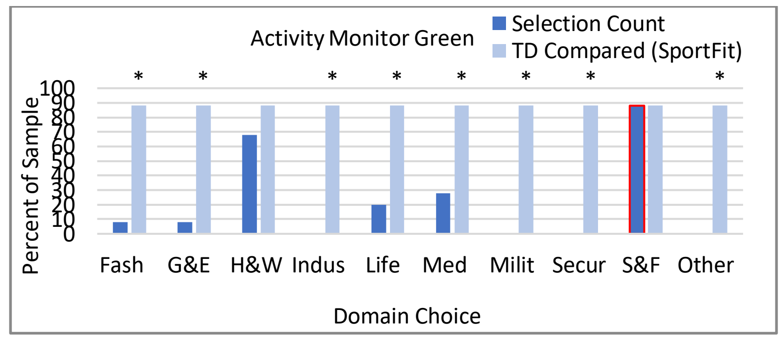


Figure D14. Domain comparison Activity Monitor Green (sample size n=25)

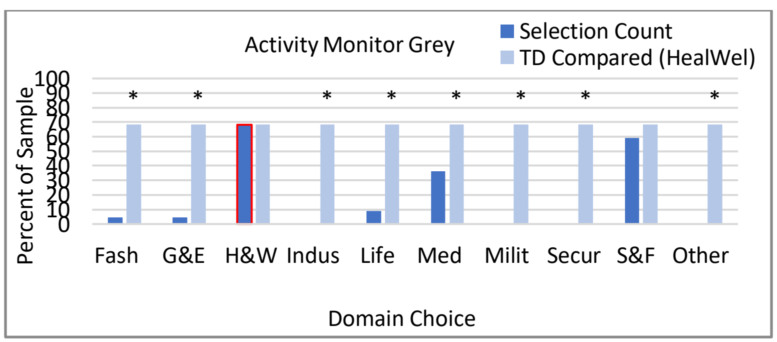


Figure D15. Domain comparison Activity Monitor Grey (sample size n=22)

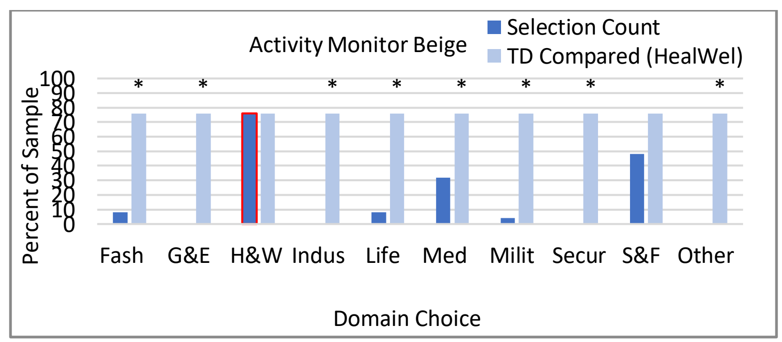


Figure D16. Domain comparison Activity Monitor Beige (sample size n=25)

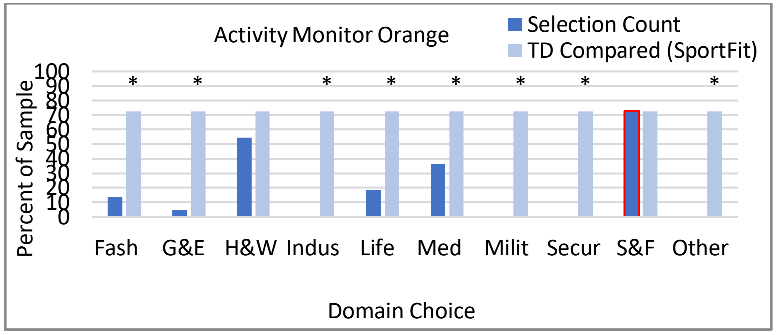


Figure D17. Domain comparison Activity Monitor Orange (sample size n=22)

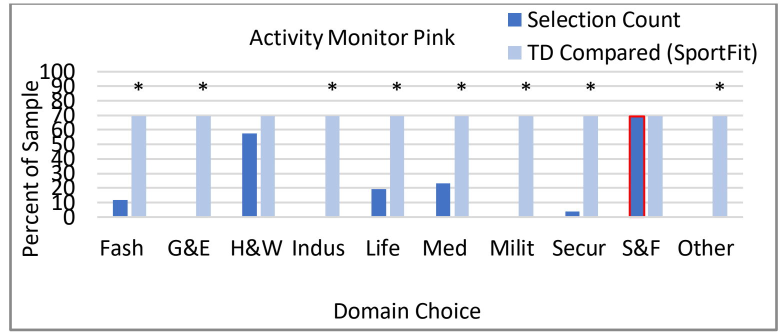


Figure D18. Domain comparison Activity Monitor Pink (sample size n=26)

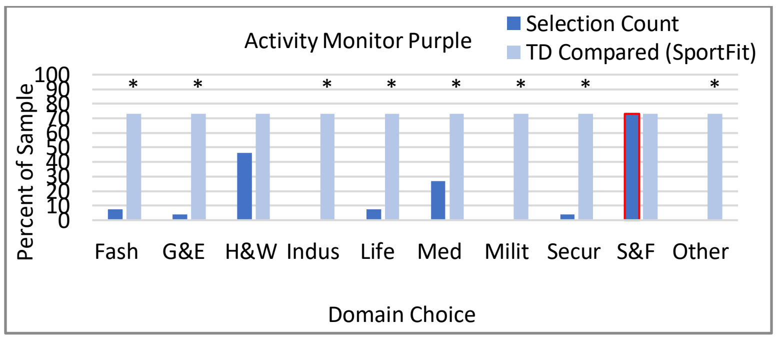


Figure D19. Domain comparison Activity Monitor Purple (sample size n=26)

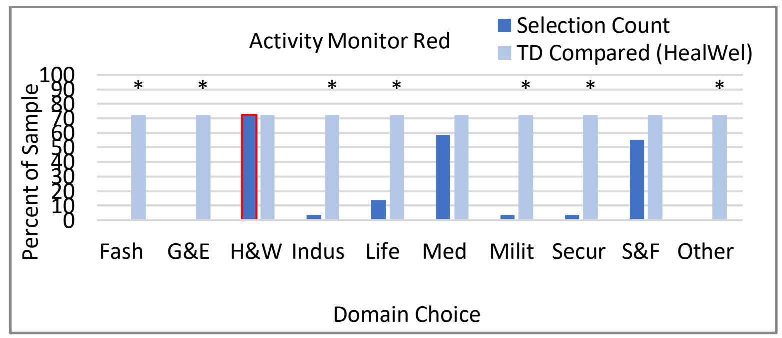


Figure D20. Domain comparison Activity Monitor Red (sample size n=29)

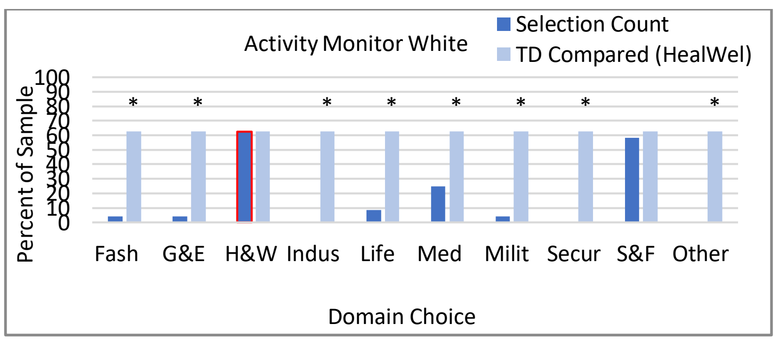


Figure D21. Domain comparison Activity Monitor White (sample size n=24)

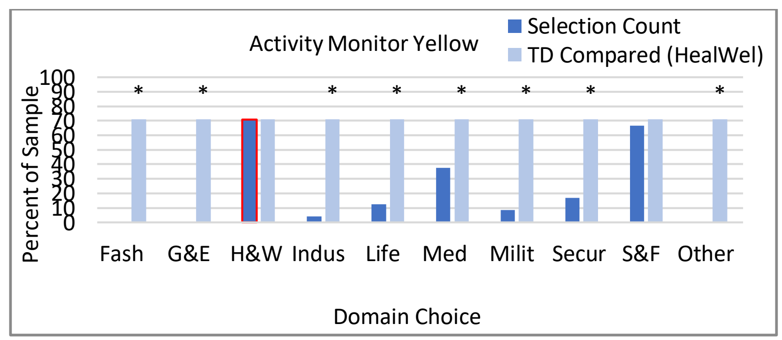


Figure D22. Domain comparison Activity Monitor Yellow (sample size n=24)

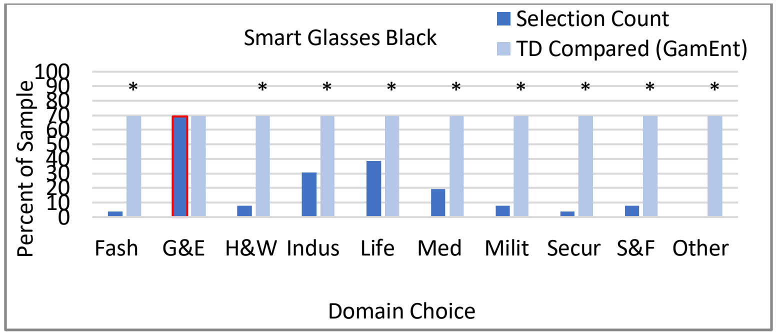


Figure D23. Domain comparison Smart Glasses Black (sample size n=26)

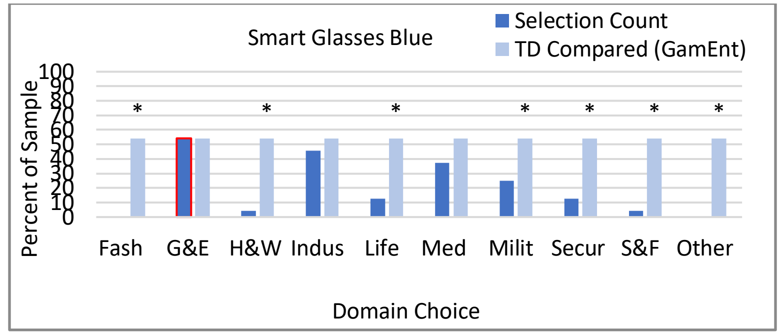


Figure D24. Domain comparison Smart Glasses Blue (sample size n=24)

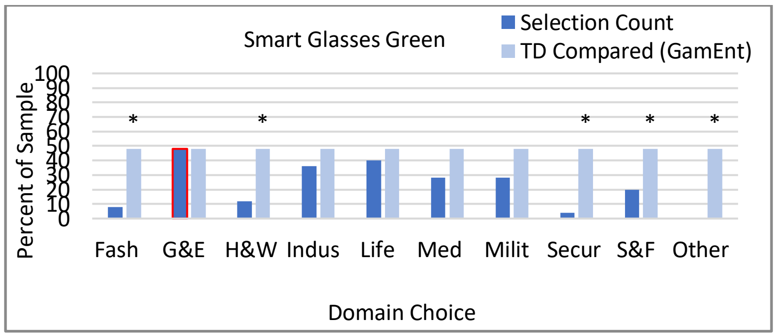


Figure D25. Domain comparison Smart Glasses Green (sample size n=25)

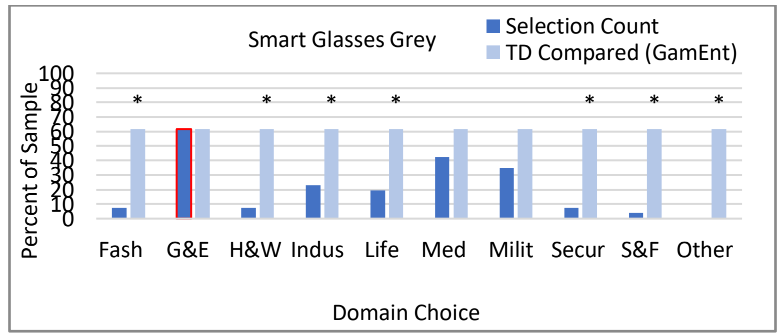


Figure D26. Domain comparison Smart Glasses Grey (sample size n=26)

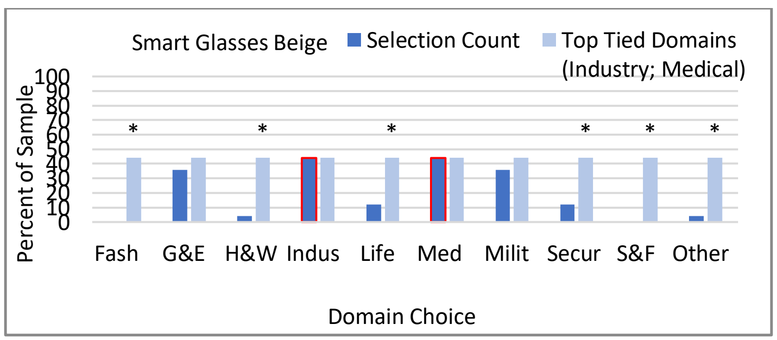


Figure D27. Domain comparison Smart Glasses Beige (sample size n=25)

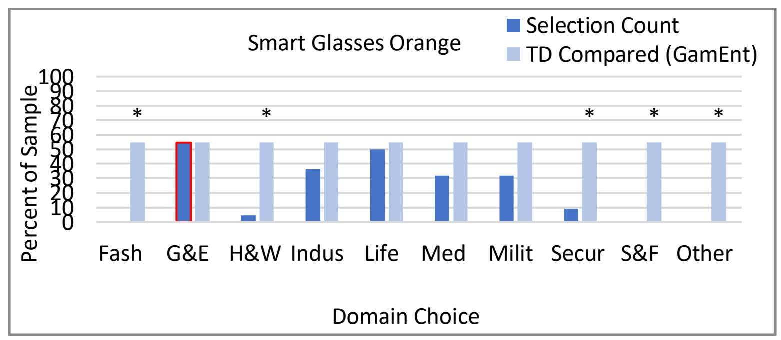


Figure D28. Domain comparison Smart Glasses Orange (sample size n=22)

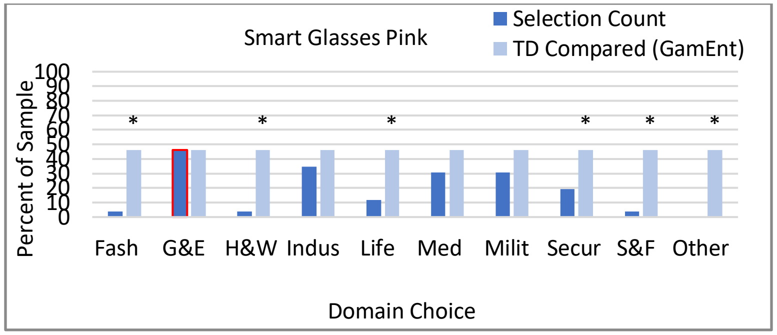


Figure D29. Domain comparison Smart Glasses Pink (sample size n=26)

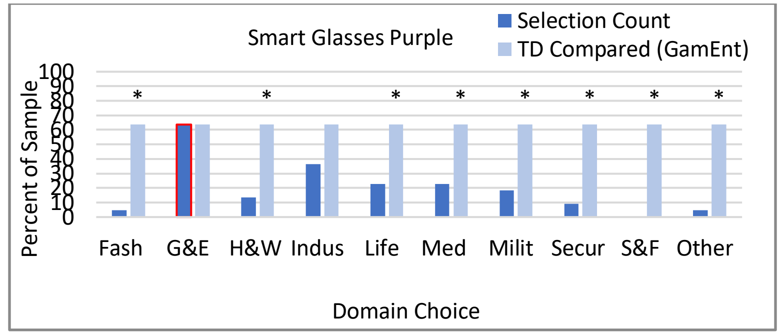


Figure D30. Domain comparison Smart Glasses Purple (sample size n=22)

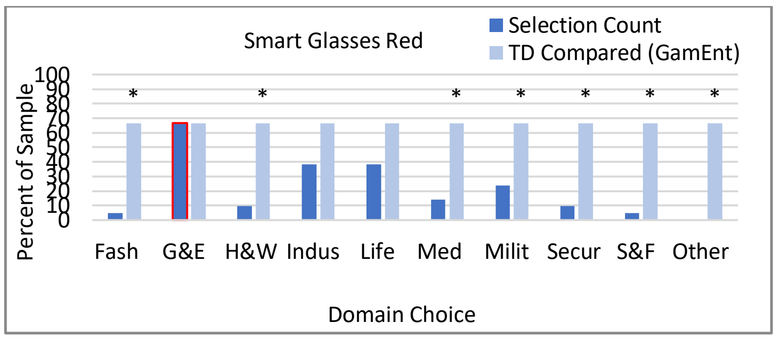


Figure D31. Domain comparison Smart Glasses Red (sample size n=21)

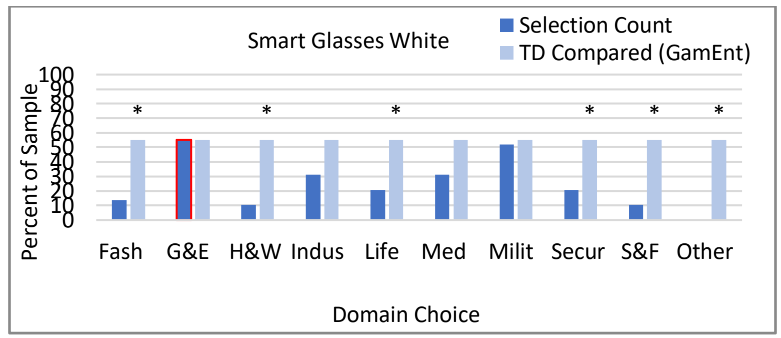


Figure D32. Domain comparison Smart Glasses White (sample size n=29)

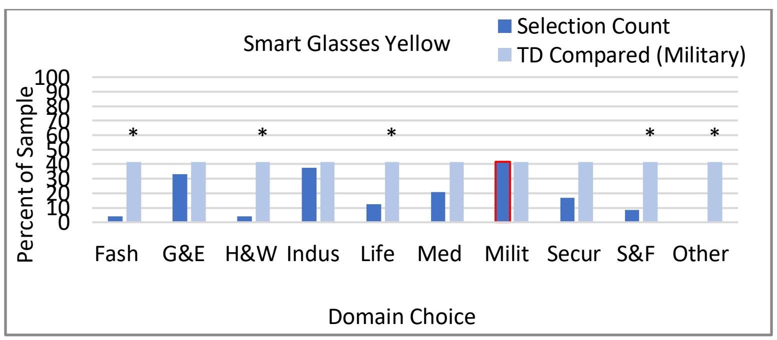


Figure D33. Domain comparison Smart Glasses Yellow (sample size n=24)

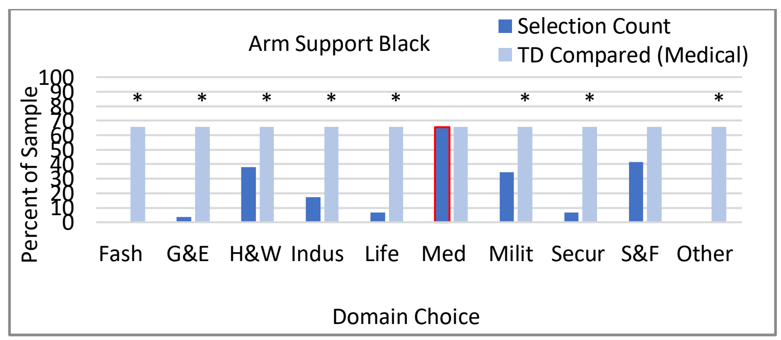


Figure D34. Domain comparison Arm Support Black (sample size n=29)

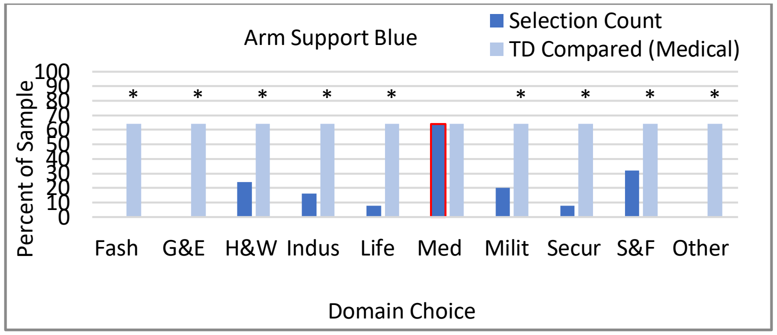


Figure D35. Domain comparison Arm Support Blue (sample size n=25)

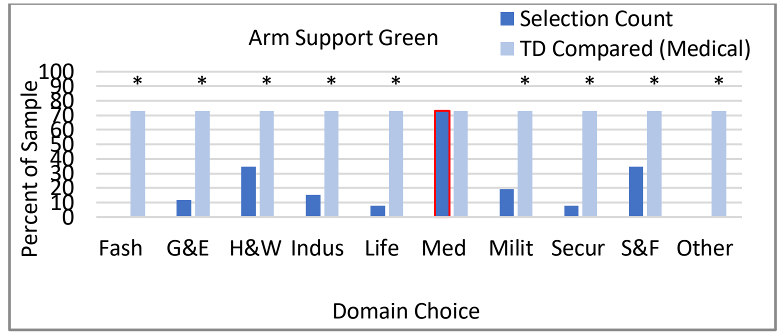


Figure D36. Domain comparison Arm Support Green (sample size n=26)

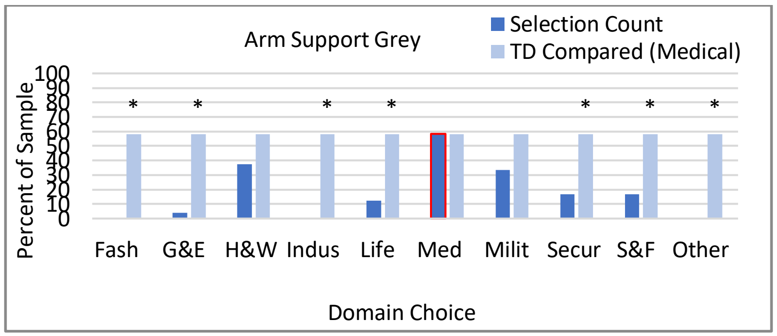


Figure D37. Domain comparison Arm Support Grey (sample size n=24)

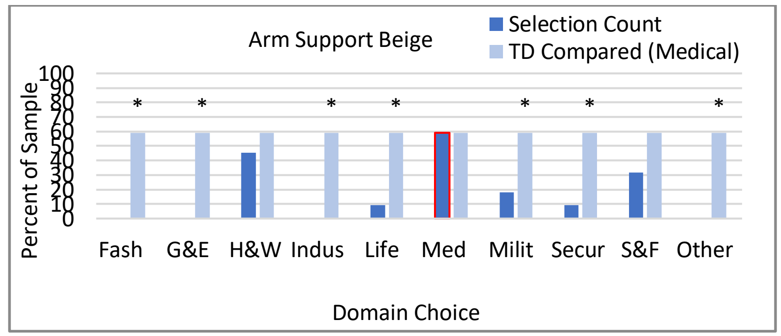


Figure D38. Domain comparison Arm Support Beige (sample size n=22)

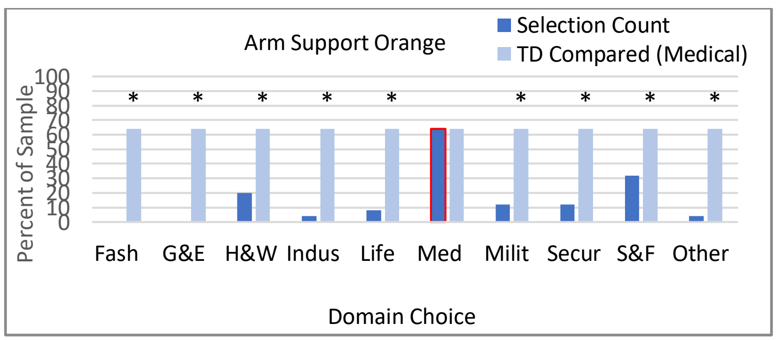


Figure D39. Domain comparison Arm Support Orange (sample size n=25)

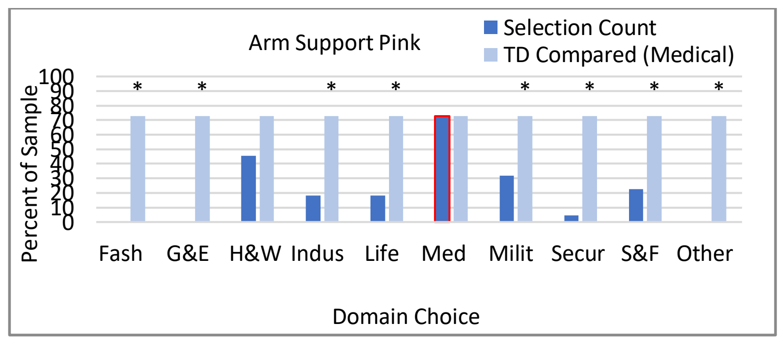


Figure D40. Domain comparison Arm Support Pink (sample size n=22)

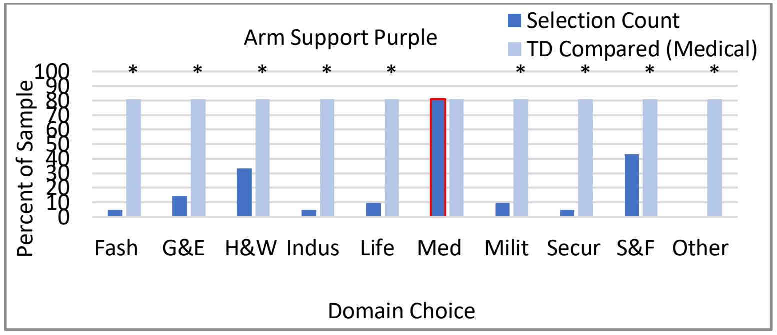


Figure D41. Domain comparison Arm Support Purple (sample size n=21)

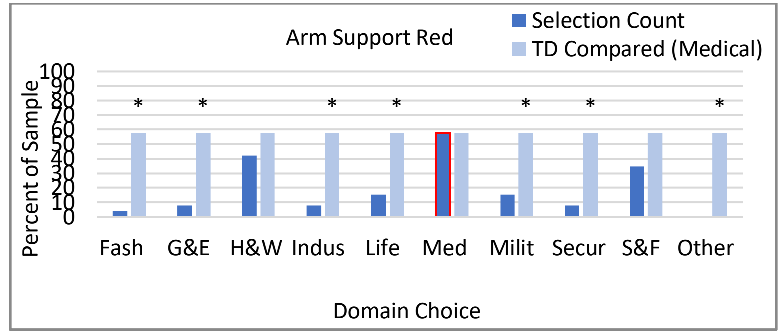


Figure D42. Domain comparison Arm Support Red (sample size n=26)

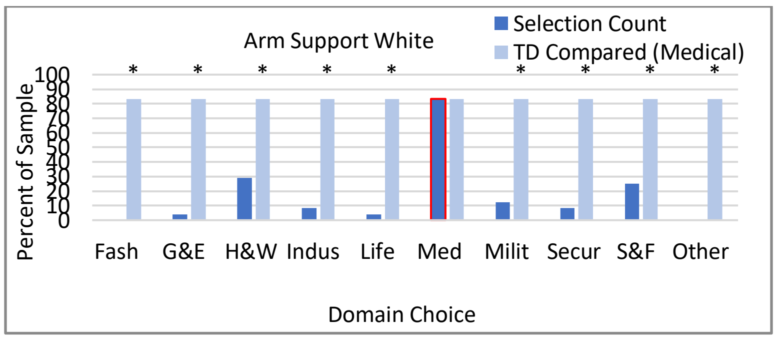


Figure D43. Domain comparison Arm Support White (sample size n=24)

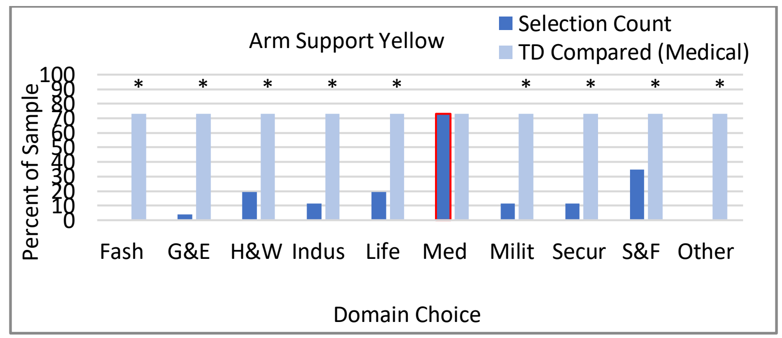


Figure D44. Domain comparison Arm Support Yellow (sample size n=26)

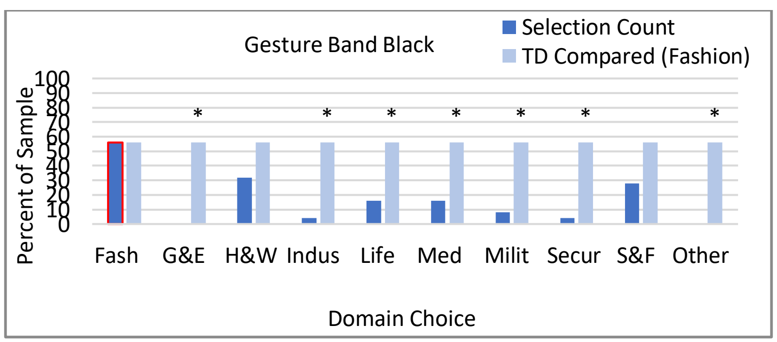


Figure D45. Domain comparison Gesture Band Black (sample size n=25)

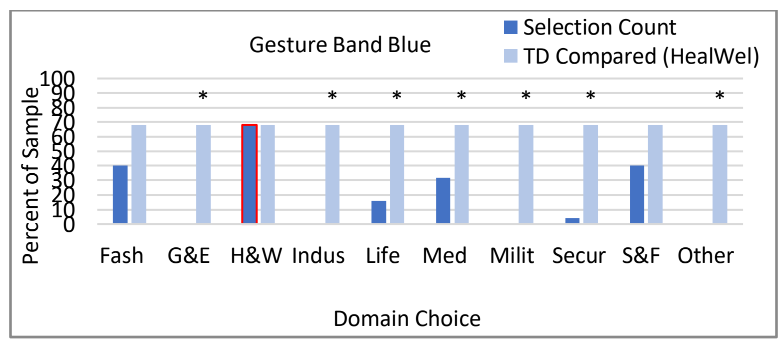


Figure D46. Domain comparison Gesture Band Blue (sample size n=25)

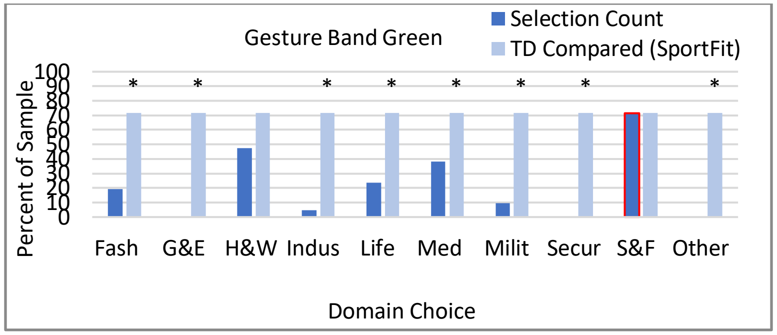


Figure D47. Domain comparison Gesture Band Green (sample size n=21)

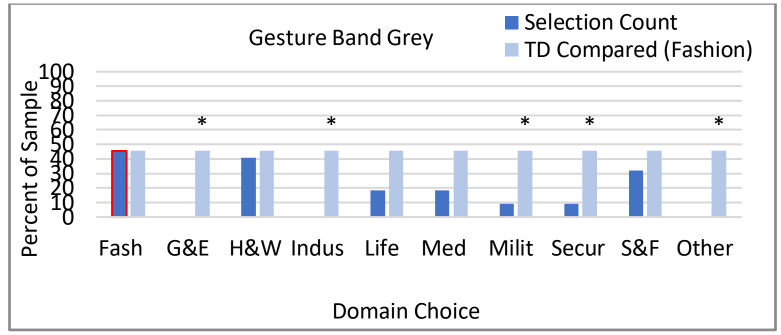


Figure D48. Domain comparison Gesture Band Grey (sample size n=22)

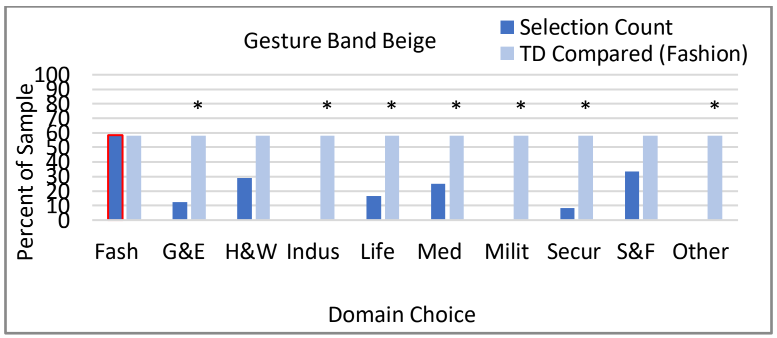


Figure D49. Domain comparison Gesture Band Beige (sample size n=24)

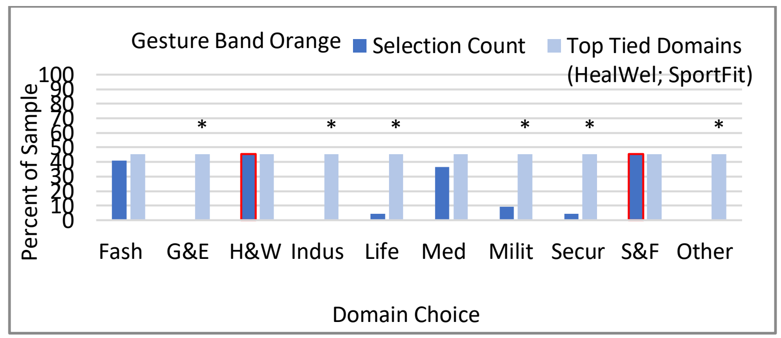


Figure D50. Domain comparison Gesture Band Orange (sample size n=22)

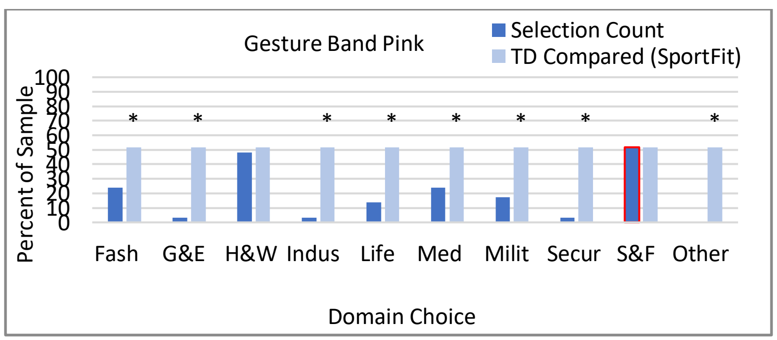


Figure D51. Domain comparison Gesture Band Pink (sample size n=29)

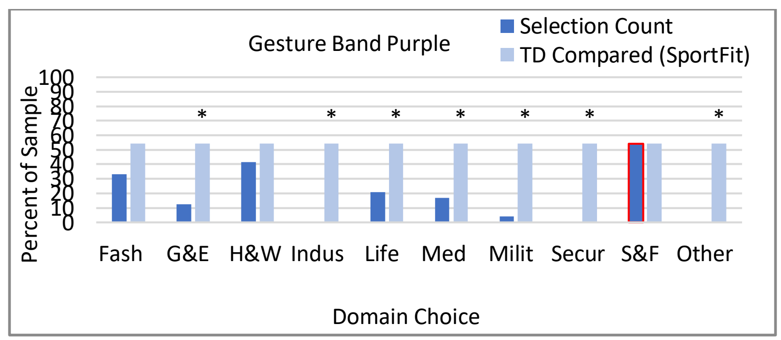


Figure D52. Domain comparison Gesture Band Purple (sample size n=24)

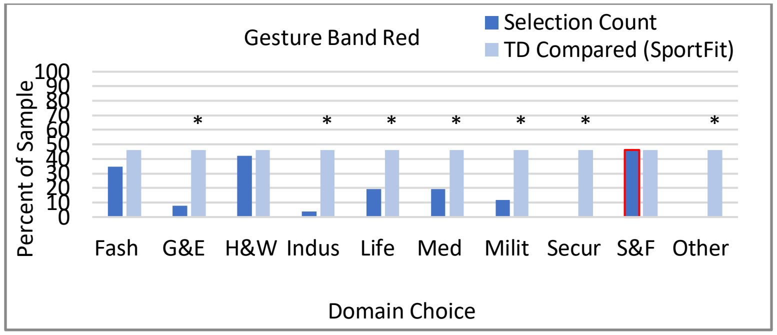


Figure D53. Domain comparison Gesture Band Red (sample size n=26)

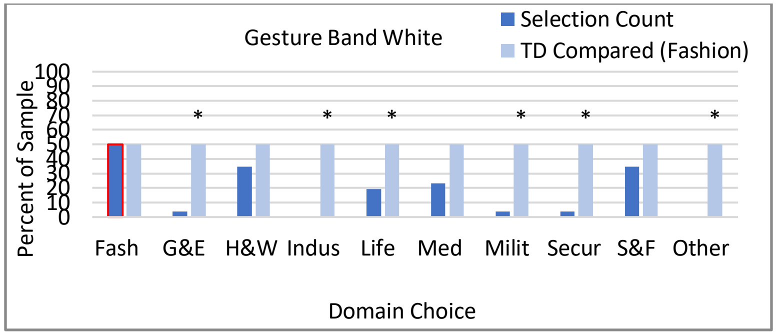


Figure D54. Domain comparison Gesture Band White (sample size n=26)

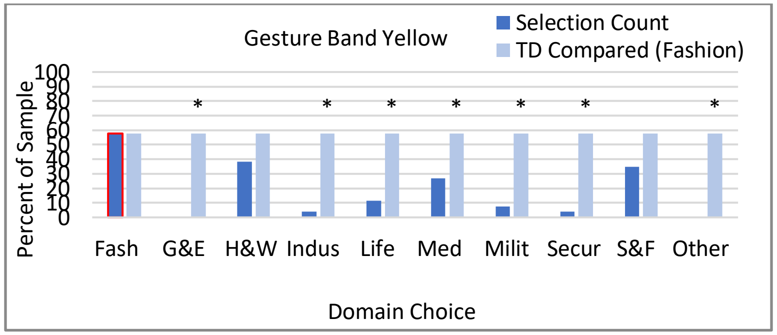


Figure D55. Domain comparison Gesture Band Yellow (sample size n=26)

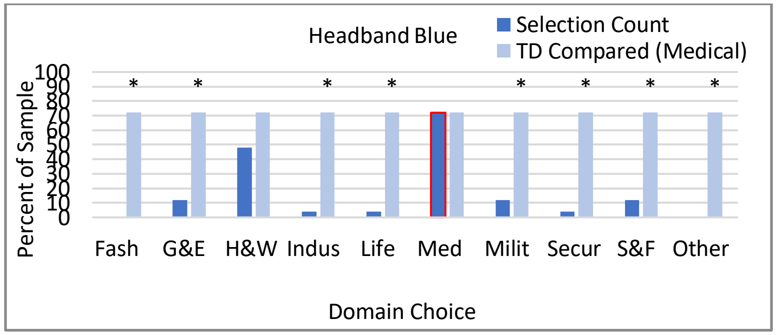


Figure D56. Domain comparison Headband Blue (sample size n=25)

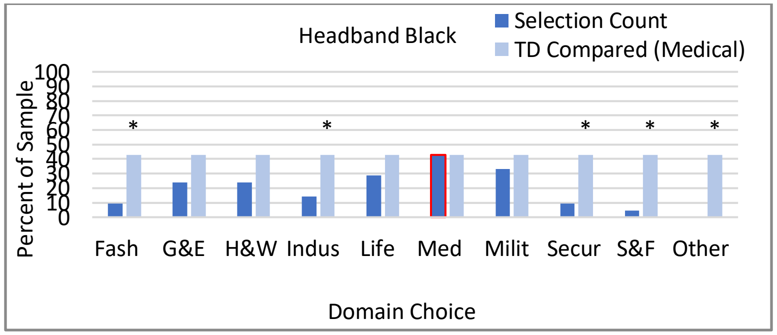


Figure D57. Domain comparison Headband Black (sample size n=21)

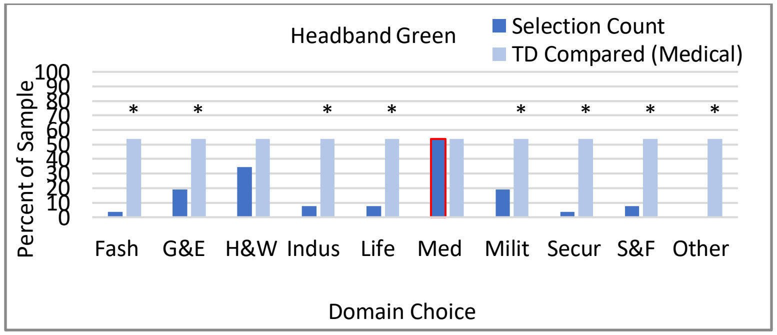


Figure D58. Domain comparison Headband Green (sample size n=26)

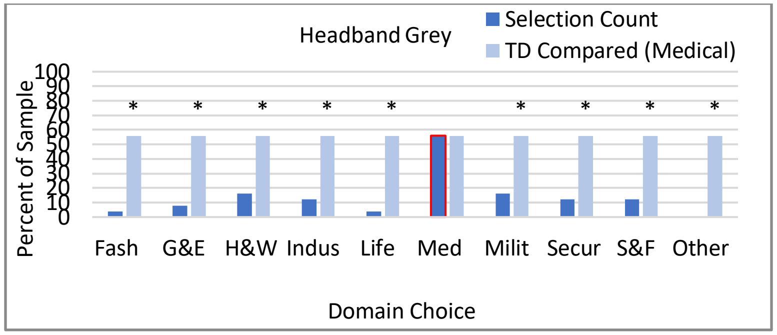


Figure D59. Domain comparison Headband Grey (sample size n=25)

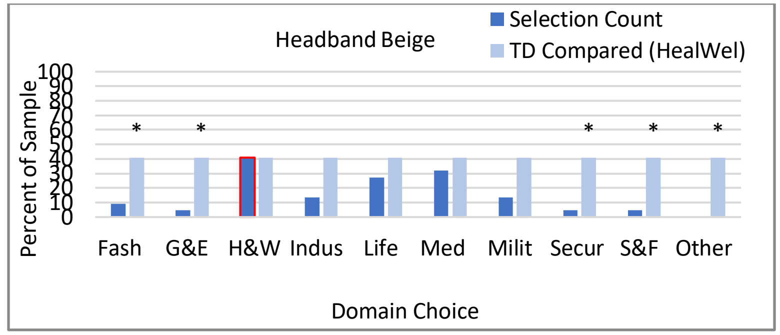


Figure D60. Domain comparison Headband Beige (sample size n=22)

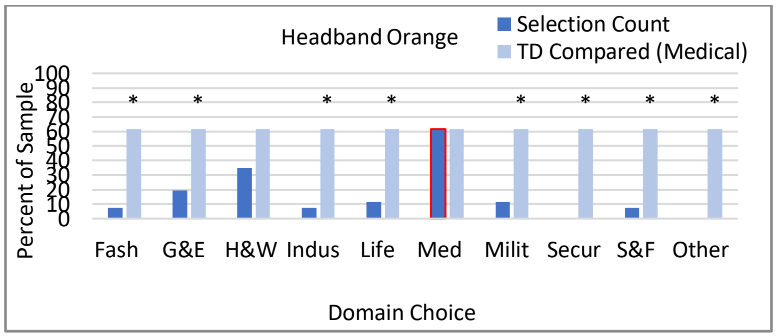


Figure D61. Domain comparison Headband Orange (sample size n=26)

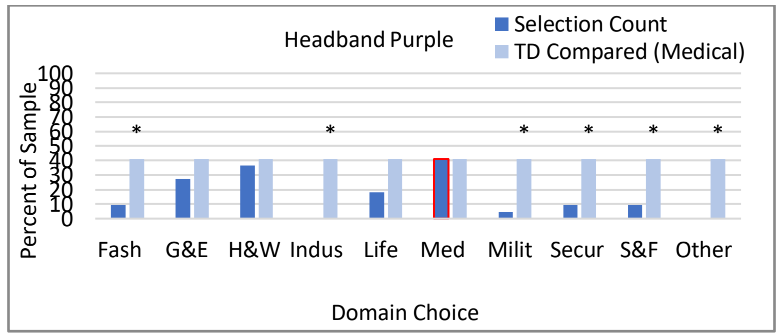


Figure D62. Domain comparison Headband Purple (sample size n=22)

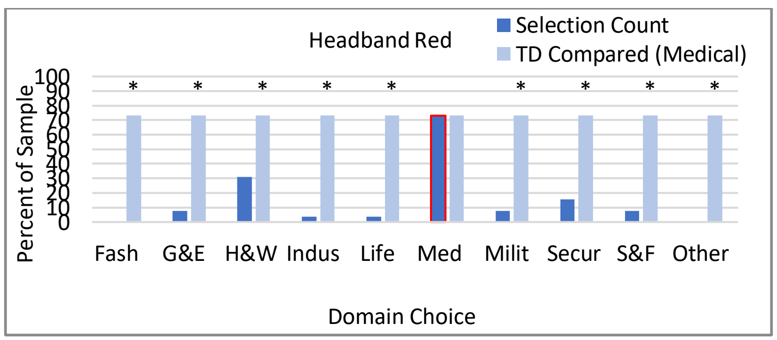


Figure D63. Domain comparison Headband Red (sample size n=26)

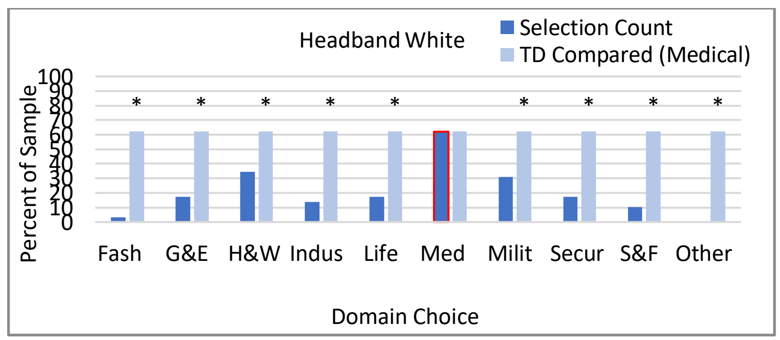


Figure D64. Domain comparison Headband White (sample size n=29)

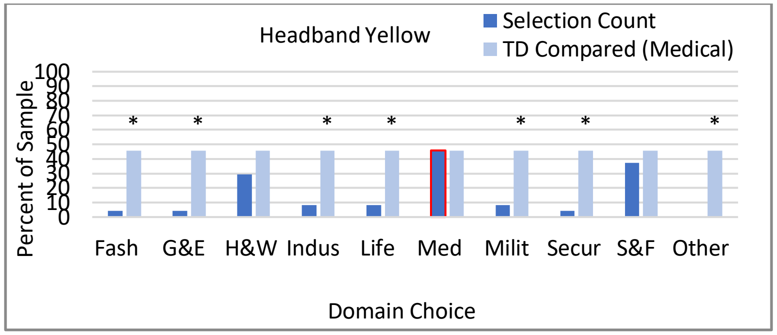


Figure D65. Domain comparison Headband Yellow (sample size n=24)

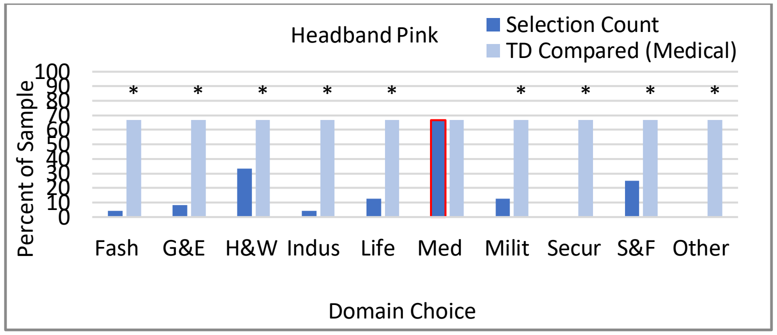
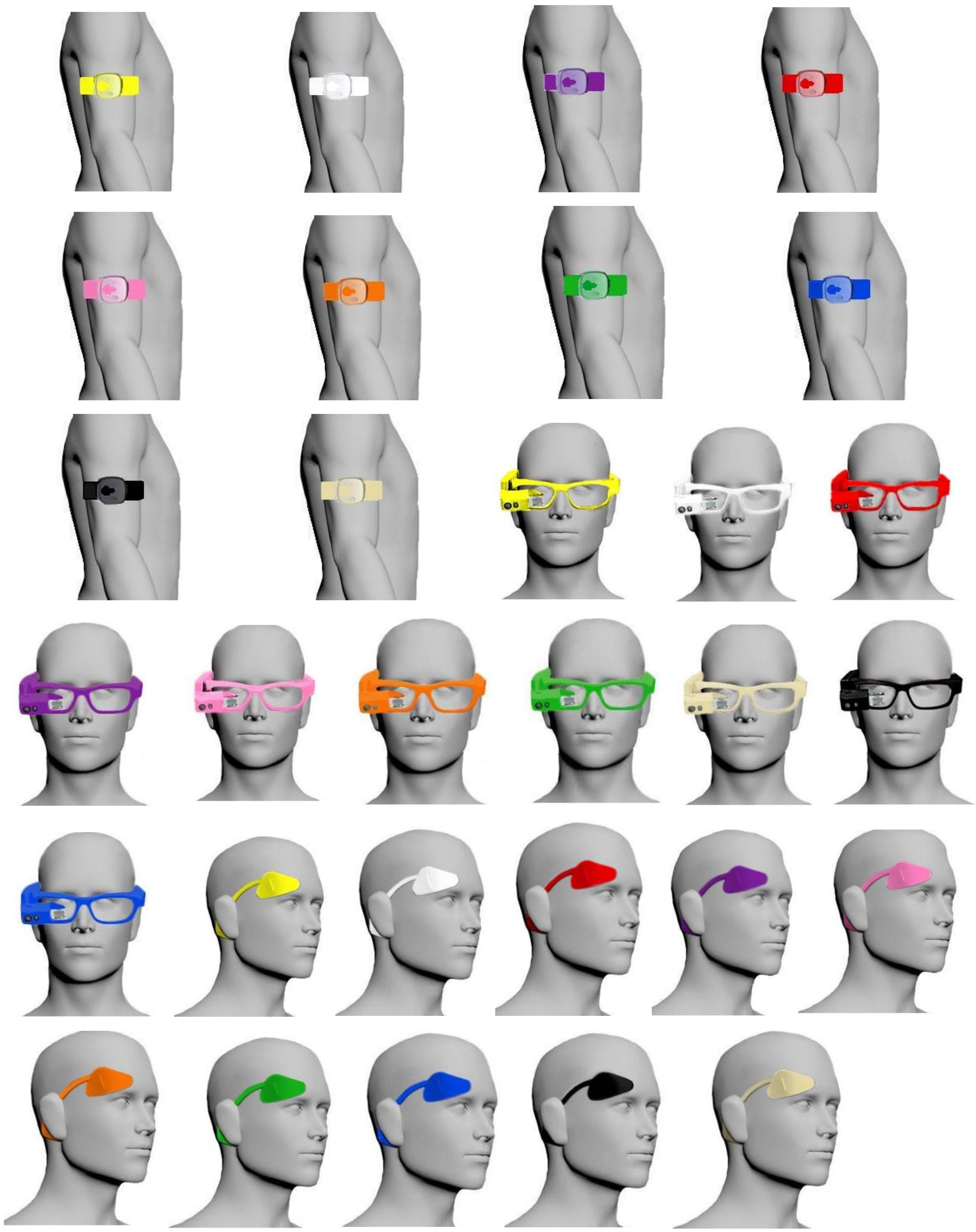


Figure D66. Domain comparison Headband Pink (sample size n=24)

Appendix E

Second Iteration Survey Images



Appendix F

Second Iteration Survey

DIRECTIONS: In the following sections you will review 3 randomly selected products. After reviewing each product, you will be asked to categorize the item. You will not be given any description of what the product is, and should make your best guess based on the picture of the product you are shown.

*Please adjust your monitor to the best visibility setting

[IMAGE]

Please select the area(s) that you know or think this product most likely belongs to. (you may select more than one)

Industry (used by someone to perform their job, usually in the production of goods or services)
Military (used by military personnel for the purposes of training or combat)
Sports/Fitness (used to assist in the performance of athletic activities)
Lifestyle (used for general, day-to-day tasks)
Gaming & Entertainment (used for recreational and entertainment purposes)
Health & Wellness (used by an everyday person to promote their health)
Fashion (used for aesthetic purposes)
Medical (used by doctors or patients for medical reasons)
Security/Safety (used for protection)
Communication (used to share or receive information)
Other, please specify

Please **now select only 1 area** (the most likely or most dominant area from all of the previous options you selected) for this product.

Your selection must be **one of the options you chose in the previous question.**

Industry (used by someone to perform their job, usually in the production of goods or services)
Military (used by military personnel for the purposes of training or combat)
Sports/Fitness (used to assist in the performance of athletic activities)
Lifestyle (used for general, day-to-day tasks)
Gaming & Entertainment (used for recreational and entertainment purposes)
Health & Wellness (used by an everyday person to promote their health)
Fashion (used for aesthetic purposes)

Medical (used by doctors or patients for medical reasons)
Security/Safety (used for protection)
Communication (used to share or receive information)
Other, please specify

[Repeat x3 images]

What is your gender?
Male
Female

What is your age?

▼

Please select your race (mark all boxes that apply):
White
Black or African American
American Indian or Alaska Native Asian
Native Hawaiian or Pacific Islander
Other ___________________________
Hispanic
Latino

To the best of your knowledge, are you color blind?
Yes, I am color blind
No, I am not color blind

Please select yes to show that you are paying attention.

Yes

No

Have you been tested for color blindness before? (Your response will not affect your submission)
Yes
No

Appendix G

Second Iteration Survey: Additional Question Version

DIRECTIONS: In the following sections you will review 3 randomly selected products. After reviewing each product, you will be asked to categorize the item. You will not be given any description of what the product is, and should make your best guess based on the picture of the product you are shown.

*Please adjust your monitor to the best visibility setting

[IMAGE]
Please select the area(s) that you know or think this product most likely belongs to. (you may select more than one)

Industry (used by someone to perform their job, usually in the production of goods or services)
Military (used by military personnel for the purposes of training or combat)
Sports/Fitness (used to assist in the performance of athletic activities)
Lifestyle (used for general, day-to-day tasks)
Gaming & Entertainment (used for recreational and entertainment purposes)
Health & Wellness (used by an everyday person to promote their health)
Fashion (used for aesthetic purposes)
Medical (used by doctors or patients for medical reasons)
Security/Safety (used for protection)
Communication (used to share or receive information)
Other, please specify ____________

Please **now select only 1 area** (the most likely or most dominant area from all of the previous options you selected) for this product.
Your selection must be **one of the options you chose in the previous question.**

Industry (used by someone to perform their job, usually in the production of goods or services)
Military (used by military personnel for the purposes of training or combat)
Sports/Fitness (used to assist in the performance of athletic activities)
Lifestyle (used for general, day-to-day tasks)
Gaming & Entertainment (used for recreational and entertainment purposes)
Health & Wellness (used by an everyday person to promote their health)
Fashion (used for aesthetic purposes)
Medical (used by doctors or patients for medical reasons)

Security/Safety (used for protection)

Communication (used to share or receive information)

Other, please specify

In your opinion, what would you assume the product is and does? In addition to listing what the product is, please include any functions or features that it might have (if any).

Is the product something that is recognizable?

Yes, please explain

No, please explain

[Repeat x3 Images]

Is the term "wearable technology" recognizable?

Yes, please explain

No, please explain

Before taking this survey, would you have categorized any of the products you saw as a "wearable technology" product? Mark all that apply.

Yes, the glasses

Yes, the arm band

Yes, the headwear

No, I wouldn't have categorized any as "wearable technology"

What is your gender?

Male

Female

What is your age?

▼

Please select your race (mark all boxes that apply):

White

Black or African American

American Indian or Alaska Native Asian

Native Hawaiian or Pacific Islander

Other ___________________________

Hispanic

Latino

To the best of your knowledge, are you color blind?

Yes, I am color blind

No, I am not color blind

Have you been tested for color blindness before? (Your response will not affect your submission)

Yes

No

Appendix H

Domain Selection Comparison Results

Table H 1. Domain Selection Comparisons for Yellow Activity Monitor

	Ind	Med	H&W	Mili	Sec	G&E	S&F	Fash	Life	Com	Other
Ind	.	0.00*	0.00*	0.03	0.13	0.09	0.00*	0.78	0.00*	0.35	0.01
Med	.	.	0.00*	0.00*	0.00*	0.00*	0.00*	0.00*	0.00	0.00*	0.00*
H&W	.	.	.	0.00*	0.00*	0.00*	0.25	0.00*	0.00*	0.00*	0.00*
Mili	.	.	.	.	0.82	1.00	0.00*	0.05	0.00*	0.55	0.00
Sec	.	.	.	.	.	0.82	0.00*	0.09	0.00*	0.64	0.00
G&E	.	.	.	.	.	.	0.00*	0.05	0.00*	0.52	0.00
S&F	.	.	.	.	.	.	.	0.00*	0.00*	0.00*	0.00*
Fash	.	.	.	.	.	.	.	.	0.00*	0.10	0.01
Life	.	.	.	.	.	.	.	.	.	0.00*	0.00*
Com	.	.	.	.	.	.	.	.	.	.	0.00
Other	.	.	.	.	.	.	.	.	.	.	.

*p<0.00003

Table H 2. Domain Selection Comparisons for White Activity Monitor

	Ind	Med	H&W	Mili	Sec	G&E	S&F	Fash	Life	Com	Other
Ind	.	0.00*	0.00*	0.00	0.01	0.00*	0.00*	0.05	0.00*	0.01	.
Med	.	.	0.00*	0.00*	0.00*	0.00*	0.00	0.00*	0.00*	0.00*	0.00*
H&W	.	.	.	0.00*	0.00*	0.00*	0.31	0.00*	0.00*	0.00*	0.00*
Mili	.	.	.	.	0.44	0.06	0.00*	0.13	0.00*	0.41	0.00
Sec	.	.	.	.	.	0.02	0.00*	0.53	0.00*	1.00	0.01
G&E	.	.	.	.	.	.	0.00*	0.00	0.00	0.00	0.00*
S&F	.	.	.	.	.	.	.	0.00*	0.00*	0.00*	0.00*
Fash	.	.	.	.	.	.	.	.	0.00*	0.48	0.05
Life	.	.	.	.	.	.	.	.	.	0.00*	0.00*
Com	.	.	.	.	.	.	.	.	.	.	0.01
Other	.	.	.	.	.	.	.	.	.	.	.

*p<0.00003

Table H 3. Domain Selection Comparisons for Purple Activity Monitor

	Ind	Med	H&W	Mili	Sec	G&E	S&F	Fash	Life	Com	Other
Ind	.	0.00*	0.00*	0.21	0.37	0.03	0.00*	0.74	0.00*	0.76	0.03
Med	.	.	0.00*	0.00*	0.00*	0.00*	0.00*	0.00*	0.00	0.00*	0.00*
H&W	.	.	.	0.00*	0.00*	0.00*	0.04	0.00*	0.00*	0.00*	0.00*
Mili	.	.	.	.	0.74	0.37	0.00*	0.17	0.00	0.41	0.00
Sec	.	.	.	.	.	0.23	0.00*	0.25	0.00	0.57	0.00
G&E	.	.	.	.	.	.	0.00*	0.03	0.00	0.09	0.00
S&F	.	.	.	.	.	.	.	0.00*	0.00*	0.00*	0.00*
Fash	.	.	.	.	.	.	.	.	0.00*	0.53	0.05
Life	.	.	.	.	.	.	.	.	.	0.00*	0.00*
Com	.	.	.	.	.	.	.	.	.	.	0.01
Other	.	.	.	.	.	.	.	.	.	.	.

*p<0.00003

Table H 4. Domain Selection Comparisons for Red Activity Monitor

	Ind	Med	H&W	Mili	Sec	G&E	S&F	Fash	Life	Com	Other
Ind	.	0.00*	0.00*	0.09	0.44	0.23	0.00*	0.10	0.00*	0.13	0.01
Med	.	.	0.00*	0.00*	0.00*	0.00*	0.00	0.00*	0.00*	0.00*	0.00*
H&W	.	.	.	0.00*	0.00*	0.00*	0.09	0.00*	0.00*	0.00*	0.00*
Mili	.	.	.	.	0.35	0.62	0.00*	0.00	0.00	1.00	0.00
Sec	.	.	.	.	.	0.64	0.00*	0.02	0.00*	0.35	0.00
G&E	.	.	.	.	.	.	0.00*	0.00	0.00*	0.57	0.00
S&F	.	.	.	.	.	.	.	0.00*	0.00*	0.00*	0.00*
Fash	.	.	.	.	.	.	.	.	0.00*	0.00	0.16
Life	.	.	.	.	.	.	.	.	.	0.00	0.00*
Com	.	.	.	.	.	.	.	.	.	.	0.00
Other	.	.	.	.	.	.	.	.	.	.	.

*p<0.00003

Table H 5. Domain Selection Comparisons for Pink Activity Monitor

	Ind	Med	H&W	Mili	Sec	G&E	S&F	Fash	Life	Com	Other
Ind	.	0.00*	0.00*	0.21	0.41	0.11	0.00*	0.76	0.00*	0.03	0.01
Med	.	.	0.00*	0.00*	0.00*	0.00*	0.00*	0.00*	0.00	0.00*	0.00*
H&W	.	.	.	0.00*	0.00*	0.00*	0.25	0.00*	0.00*	0.00*	0.00*
Mili	.	.	.	.	0.78	0.60	0.00*	0.41	0.00*	0.47	0.00
Sec	.	.	.	.	.	0.44	0.00*	0.53	0.00*	0.37	0.00
G&E	.	.	.	.	.	.	0.00*	0.20	0.00*	0.81	0.00
S&F	.	.	.	.	.	.	.	0.00*	0.00*	0.00*	0.00*
Fash	.	.	.	.	.	.	.	.	0.00*	0.16	0.01
Life	.	.	.	.	.	.	.	.	.	0.00*	0.00*
Com	.	.	.	.	.	.	.	.	.	.	0.00
Other	.	.	.	.	.	.	.	.	.	.	.

*p<0.00003

Table H 6. Domain Selection Comparisons for Orange Activity Monitor

	Ind	Med	H&W	Mili	Sec	G&E	S&F	Fash	Life	Com	Other
Ind	.	0.00*	0.00*	0.09	0.42	0.00	0.00*	1.00	0.00*	0.00	0.18
Med	.	.	0.00*	0.00*	0.00*	0.00*	0.00*	0.00*	0.52	0.00*	0.00*
H&W	.	.	.	0.00*	0.00*	0.00*	0.60	0.00*	0.00*	0.00*	0.00*
Mili	.	.	.	.	0.25	0.07	0.00*	0.11	0.00*	0.16	0.01
Sec	.	.	.	.	.	0.00	0.00*	0.53	0.00*	0.03	0.06
G&E	.	.	.	.	.	.	0.00*	0.00	0.00*	0.57	0.00
S&F	.	.	.	.	.	.	.	0.00*	0.00*	0.00*	0.00*
Fash	.	.	.	.	.	.	.	.	0.00*	0.01	0.18
Life	.	.	.	.	.	.	.	.	.	0.00*	0.00*
Com	.	.	.	.	.	.	.	.	.	.	0.00
Other	.	.	.	.	.	.	.	.	.	.	.

*p<0.00003

Table H 7. Domain Selection Comparisons for Green Activity Monitor

	Ind	Med	H&W	Mili	Sec	G&E	S&F	Fash	Life	Com	Other
Ind	.	0.00*	0.00*	0.01	0.66	0.01	0.00*	1.00	0.00*	0.08	0.08
Med	.	.	0.00*	0.00*	0.00*	0.00*	0.00	0.00*	0.00*	0.00*	0.00*
H&W	.	.	.	0.00*	0.00*	0.00*	0.23	0.00*	0.00*	0.00*	0.00*
Mili	.	.	.	.	0.01	1.00	0.00*	0.01	0.00	0.52	0.00
Sec	.	.	.	.	.	0.01	0.00*	0.57	0.00*	0.03	0.16
G&E	.	.	.	.	.	.	0.00*	0.01	0.00	0.49	0.00
S&F	.	.	.	.	.	.	.	0.00*	0.00*	0.00*	0.00*
Fash	.	.	.	.	.	.	.	.	0.00*	0.06	0.08
Life	.	.	.	.	.	.	.	.	.	0.00*	0.00*
Com	.	.	.	.	.	.	.	.	.	.	0.00
Other	.	.	.	.	.	.	.	.	.	.	.

*p<0.00003

Table H 8. Domain Selection Comparisons for Blue Activity Monitor

	Ind	Med	H&W	Mili	Sec	G&E	S&F	Fash	Life	Com	Other
Ind	.	0.00*	0.00*	0.03	0.05	0.17	0.00*	1.00	0.00*	0.02	0.03
Med	.	.	0.00*	0.00*	0.00*	0.00*	0.00*	0.00*	0.00	0.00*	0.00*
H&W	.	.	.	0.00*	0.00*	0.00*	0.17	0.00*	0.00*	0.00*	0.00*
Mili	.	.	.	.	1.00	0.62	0.00*	0.07	0.00*	0.81	0.00
Sec	.	.	.	.	.	0.64	0.00*	0.07	0.00*	0.80	0.00
G&E	.	.	.	.	.	.	0.00*	0.13	0.00*	0.50	0.00
S&F	.	.	.	.	.	.	.	0.00*	0.00*	0.00*	0.00*
Fash	.	.	.	.	.	.	.	.	0.00*	0.05	0.03
Life	.	.	.	.	.	.	.	.	.	0.00*	0.00*
Com	.	.	.	.	.	.	.	.	.	.	0.00
Other	.	.	.	.	.	.	.	.	.	.	.

$^*p<0.00003$

Table H 9. Domain Selection Comparisons for Black Activity Monitor

	Ind	Med	H&W	Mili	Sec	G&E	S&F	Fash	Life	Com	Other
Ind	.	0.00*	0.00*	0.00	0.00	0.00	0.00*	0.05	0.00*	0.00	.
Med	.	.	0.00*	0.00*	0.00*	0.00*	0.00*	0.00*	0.01	0.00*	0.00*
H&W	.	.	.	0.00*	0.00*	0.00*	0.10	0.00*	0.00*	0.00*	0.00*
Mili	.	.	.	.	1.00	1.00	0.00*	0.07	0.00*	0.60	0.00
Sec	.	.	.	.	.	1.00	0.00*	0.07	0.00*	0.57	0.00
G&E	.	.	.	.	.	.	0.00*	0.05	0.00*	0.64	0.00
S&F	.	.	.	.	.	.	.	0.00*	0.00*	0.00*	0.00*
Fash	.	.	.	.	.	.	.	.	0.00*	0.17	0.05
Life	.	.	.	.	.	.	.	.	.	0.00*	0.00*
Com	.	.	.	.	.	.	.	.	.	.	0.00
Other	.	.	.	.	.	.	.	.	.	.	.

$^*p<0.00003$

Table H 10. Domain Selection Comparisons for Beige Activity Monitor

	Ind	Med	H&W	Mili	Sec	G&E	S&F	Fash	Life	Com	Other
Ind	.	0.00*	0.00*	0.03	0.74	0.20	0.00*	0.48	0.00*	0.17	0.03
Med	.	.	0.00	0.00*	0.00*	0.00*	0.00	0.00*	0.00*	0.00*	0.00*
H&W	.	.	.	0.00*	0.00*	0.00*	0.39	0.00*	0.00*	0.00*	0.00*
Mili	.	.	.	.	0.00	0.37	0.00*	0.01	0.00	0.37	0.00
Sec	.	.	.	.	.	0.11	0.00*	0.71	0.00*	0.08	0.05
G&E	.	.	.	.	.	.	0.00*	0.02	0.00*	1.00	0.00
S&F	.	.	.	.	.	.	.	0.00*	0.00*	0.00*	0.00*
Fash	.	.	.	.	.	.	.	.	0.00*	0.03	0.08
Life	.	.	.	.	.	.	.	.	.	0.00*	0.00*
Com	.	.	.	.	.	.	.	.	.	.	0.00
Other	.	.	.	.	.	.	.	.	.	.	.

*p<0.00003

Table H 11. Domain Selection Comparisons for Yellow Smart Glasses

	Ind	Med	H&W	Mili	Sec	G&E	S&F	Fash	Life	Com	Other
Ind	.	0.03	0.00*	0.01	0.00*	0.56	0.00*	0.00*	0.00*	0.01	0.00*
Med	.	.	0.00*	0.60	0.00	0.02	0.00*	0.00*	0.00	0.37	0.00*
H&W	.	.	.	0.00*	0.08	0.00*	0.25	0.37	0.09	0.00*	0.00
Mili	.	.	.	.	0.00	0.00	0.00*	0.00*	0.00	0.62	0.00*
Sec	.	.	.	.	.	0.00*	0.01	0.01	0.88	0.00	0.00*
G&E	.	.	.	.	.	.	0.00*	0.00*	0.00*	0.00	0.00*
S&F	.	.	.	.	.	.	.	0.81	0.00	0.00*	0.03
Fash	.	.	.	.	.	.	.	.	0.00	0.00*	0.02
Life	.	.	.	.	.	.	.	.	.	0.00	0.00*
Com	.	.	.	.	.	.	.	.	.	.	0.00*
Other	.	.	.	.	.	.	.	.	.	.	.

*p<0.00003

Table H 12. Domain Selection Comparisons for White Smart Glasses

	Ind	Med	H&W	Mili	Sec	G&E	S&F	Fash	Life	Com	Other
Ind	.	0.77	0.00	0.06	0.00	0.00*	0.00*	0.00*	0.81	0.08	0.00*
Med	.	.	0.00*	0.11	0.00*	0.00*	0.00*	0.00*	0.66	0.08	0.00*
H&W	.	.	.	0.02	1.00	0.00*	0.00	0.44	0.00*	0.00*	0.00
Mili	.	.	.	.	0.00	0.00*	0.00*	0.00	0.04	0.00	0.00*
Sec	.	.	.	.	.	0.00*	0.00	0.50	0.00	0.00*	0.00
G&E	.	.	.	.	.	.	0.00*	0.00*	0.00*	0.00	0.00*
S&F	.	.	.	.	.	.	.	0.00	0.00*	0.00*	0.26
Fash	.	.	.	.	.	.	.	.	0.00*	0.00*	0.00
Life	.	.	.	.	.	.	.	.	.	0.10	0.00*
Com	.	.	.	.	.	.	.	.	.	.	0.00*
Other	.	.	.	.	.	.	.	.	.	.	.

*p<0.00003

Table H 13. Domain Selection Comparisons for Purple Smart Glasses

	Ind	Med	H&W	Mili	Sec	G&E	S&F	Fash	Life	Com	Other
Ind	.	0.56	0.00*	0.01	0.00	0.00	0.00*	0.00*	0.27	1.00	0.00*
Med	.	.	0.00*	0.00	0.00*	0.00	0.00*	0.00*	0.13	0.67	0.00*
H&W	.	.	.	0.00	0.20	0.00*	0.06	0.03	0.00	0.00*	0.00
Mili	.	.	.	.	0.06	0.00*	0.00*	0.00*	0.20	0.01	0.00*
Sec	.	.	.	.	.	0.00*	0.00	0.00	0.01	0.00	0.00*
G&E	.	.	.	.	.	.	0.00*	0.00*	0.00*	0.00*	0.00*
S&F	.	.	.	.	.	.	.	0.53	0.00*	0.00*	0.03
Fash	.	.	.	.	.	.	.	.	0.00*	0.00*	0.10
Life	.	.	.	.	.	.	.	.	.	0.16	0.00*
Com	.	.	.	.	.	.	.	.	.	.	0.00*
Other	.	.	.	.	.	.	.	.	.	.	.

*p<0.00003

Table H 14. Domain Selection Comparisons for Red Smart Glasses

	Ind	Med	H&W	Mili	Sec	G&E	S&F	Fash	Life	Com	Other
Ind	.	0.10	0.00*	0.00	0.00*	0.06	0.00*	0.00*	0.00*	0.03	0.00*
Med	.	.	0.00*	0.10	0.00	0.00	0.00*	0.00*	0.00	0.43	0.00*
H&W	.	.	.	0.00*	0.00	0.00*	0.80	0.03	0.00	0.00*	0.00
Mili	.	.	.	.	0.11	0.00*	0.00*	0.00*	0.08	0.53	0.00*
Sec	.	.	.	.	.	0.00*	0.00	0.00*	0.70	0.04	0.00*
G&E	.	.	.	.	.	.	0.00*	0.00*	0.00*	0.00*	0.00*
S&F	.	.	.	.	.	.	.	0.07	0.00	0.00*	0.00
Fash	.	.	.	.	.	.	.	.	0.00*	0.00*	0.18
Life	.	.	.	.	.	.	.	.	.	0.01	0.00*
Com	.	.	.	.	.	.	.	.	.	.	0.00*
Other	.	.	.	.	.	.	.	.	.	.	.

*p<0.00003

Table H 15. Domain Selection Comparisons for Pink Smart Glasses

	Ind	Med	H&W	Mili	Sec	G&E	S&F	Fash	Life	Com	Other
Ind	.	0.51	0.00*	0.02	0.00*	0.00*	0.00*	0.00*	0.91	0.40	0.00*
Med	.	.	0.00*	0.06	0.00	0.00*	0.00*	0.00*	0.58	0.23	0.00*
H&W	.	.	.	0.01	0.45	0.00*	0.35	0.18	0.00*	0.00*	0.00
Mili	.	.	.	.	0.05	0.00*	0.00	0.00	0.03	0.00	0.00*
Sec	.	.	.	.	.	0.00*	0.12	0.03	0.00	0.00*	0.00*
G&E	.	.	.	.	.	.	0.00*	0.00*	0.00*	0.00*	0.00*
S&F	.	.	.	.	.	.	.	0.53	0.00*	0.00*	0.00
Fash	.	.	.	.	.	.	.	.	0.00*	0.00*	0.01
Life	.	.	.	.	.	.	.	.	.	0.39	0.00*
Com	.	.	.	.	.	.	.	.	.	.	0.00*
Other	.	.	.	.	.	.	.	.	.	.	.

*p<0.00003

Table H 16. Domain Selection Comparisons for Orange Smart Glasses

	Ind	Med	H&W	Mili	Sec	G&E	S&F	Fash	Life	Com	Other
Ind	.	0.79	0.00*	0.03	0.00*	0.01	0.00*	0.00*	0.01	0.63	0.00*
Med	.	.			0.82	0.00*					
H&W	.	.	.	0.00*	0.02	0.00*	0.80	0.09	0.00	0.00*	0.00
Mili	.	.	.	.	0.00	0.00*	0.00*	0.00*	0.27	0.16	0.00*
Sec	.	.	.	.	.	0.00*	0.01	0.00	0.10	0.00*	0.00*
G&E	.	.	.	.	.	.	0.00*	0.00*	0.00*	0.00*	0.00*
S&F	.	.	.	.	.	.	.	0.13	0.00*	0.00*	0.00
Fash	.	.	.	.	.	.	.	.	0.00*	0.00*	0.03
Life	.	.	.	.	.	.	.	.	.	0.00	0.00*
Com	.	.	.	.	.	.	.	.	.	.	0.00*
Other	.	.	.	.	.	.	.	.	.	.	.

*p<0.00003

Table H 17. Domain Selection Comparisons for Green Smart Glasses

	Ind	Med	H&W	Mili	Sec	G&E	S&F	Fash	Life	Com	Other
Ind	.	0.68	0.00*	0.00	0.00*	0.08	0.00*	0.00*	0.00	0.60	0.00*
Med	.	.	0.00*	0.00	0.00*	0.03	0.00*	0.00*	0.00	0.84	0.00*
H&W	.	.	.	0.00	0.15	0.00*	0.05	0.03	0.01	0.00*	0.00
Mili	.	.	.	.	0.03	0.00*	0.00*	0.00*	0.53	0.00	0.00*
Sec	.	.	.	.	.	0.00*	0.00	0.00	0.19	0.00*	0.00*
G&E	.	.	.	.	.	.	0.00*	0.00*	0.00*	0.00	0.00*
S&F	.	.	.	.	.	.	.	0.57	0.00*	0.00*	0.02
Fash	.	.	.	.	.	.	.	.	0.00*	0.00*	0.03
Life	.	.	.	.	.	.	.	.	.	0.00*	0.00*
Com	.	.	.	.	.	.	.	.	.	.	0.00*
Other	.	.	.	.	.	.	.	.	.	.	.

*p<0.00003; note: Ind vs Life was not significant, while Comm vs Life was. Industry's count was slightly higher than Communication so one would expect it to be significant as well. This finding was either a software error or possibly the result of the paired-aspect of the test. The finding did not alter Top Domain results.

Table H 18. Domain Selection Comparisons for Blue Smart Glasses

	Ind	Med	H&W	Mili	Sec	G&E	S&F	Fash	Life	Com	Other
Ind	.	0.26	0.00*	0.00*	0.00*	0.91	0.00*	0.00*	0.00	0.06	0.00*
Med	.	.	0.00*	0.00	0.00*	0.39	0.00*	0.00*	0.00	0.46	0.00*
H&W	.	.	.	0.00	0.45	0.00*	0.00	0.01	0.00	0.00*	0.00
Mili	.	.	.	.	0.00	0.00*	0.00*	0.00*	1.00	0.02	0.00*
Sec	.	.	.	.	.	0.00*	0.00	0.00	0.00	0.00*	0.00
G&E	.	.	.	.	.	.	0.00*	0.00*	0.00*	0.03	0.00*
S&F	.	.	.	.	.	.	.	1.00	0.00*	0.00*	0.16
Fash	.	.	.	.	.	.	.	.	0.00*	0.00*	0.16
Life	.	.	.	.	.	.	.	.	.	0.01	0.00*
Com	.	.	.	.	.	.	.	.	.	.	0.00*
Other	.	.	.	.	.	.	.	.	.	.	.

*p<0.00003

Table H 19. Domain Selection Comparisons for Black Smart Glasses

	Ind	Med	H&W	Mili	Sec	G&E	S&F	Fash	Life	Com	Other
Ind	.	0.37	0.00*	0.27	0.00*	0.00	0.00*	0.00*	0.02	0.37	0.00*
Med	.	.	0.00*	0.06	0.00*	0.02	0.00*	0.00*	0.01	1.00	0.00*
H&W	.	.	.	0.00	0.87	0.00*	0.05	0.00	0.01	0.00*	0.00*
Mili	.	.	.	.	0.00*	0.00*	0.00*	0.00*	0.22	0.05	0.00*
Sec	.	.	.	.	.	0.00*	0.09	0.00	0.01	0.00*	0.00*
G&E	.	.	.	.	.	.	0.00*	0.00*	0.00*	0.00	0.00*
S&F	.	.	.	.	.	.	.	0.02	0.00	0.00*	0.00
Fash	.	.	.	.	.	.	.	.	0.00*	0.00*	0.10
Life	.	.	.	.	.	.	.	.	.	0.00	0.00*
Com	.	.	.	.	.	.	.	.	.	.	0.00*
Other	.	.	.	.	.	.	.	.	.	.	.

*p<0.00003

Table H 20. Domain Selection Comparisons for Beige Smart Glasses

	Ind	Med	H&W	Mili	Sec	G&E	S&F	Fash	Life	Com	Other
Ind	.	0.36	0.00*	0.00	0.00*	0.75	0.00*	0.00*	0.00	0.01	0.00*
Med	.	.	0.00*	0.00	0.00*	0.68	0.00*	0.00*	0.00*	0.00	0.00*
H&W	.	.	.	0.00	0.15	0.00*	0.00	0.00	0.01	0.00	0.00
Mili	.	.	.	.	0.01	0.00	0.00*	0.00*	0.18	0.68	0.00*
Sec	.	.	.	.	.	0.00*	0.00	0.00*	0.34	0.01	0.00*
G&E	.	.	.	.	.	.	0.00*	0.00*	0.00*	0.00	0.00*
S&F	.	.	.	.	.	.	.	0.74	0.00*	0.00*	0.21
Fash	.	.	.	.	.	.	.	.	0.00*	0.00*	0.32
Life	.	.	.	.	.	.	.	.	.	0.04	0.00*
Com	.	.	.	.	.	.	.	.	.	.	0.00*
Other	.	.	.	.	.	.	.	.	.	.	.

*p<0.00003

Table H 21. Domain Selection Comparisons for Yellow Headband

	Ind	Med	H&W	Mili	Sec	G&E	S&F	Fash	Life	Com	Other
Ind	.	0.00*	0.00*	0.04	0.37	0.00	0.00	0.02	0.53	0.00*	0.00
Med	.	.	0.00	0.00*	0.00*	0.00*	0.00*	0.00*	0.00*	0.00*	0.00*
H&W	.	.	.	0.00*	0.00*	0.00*	0.00*	0.00*	0.00*	0.00*	0.00*
Mili	.	.	.	.	0.01	0.28	0.05	0.00	0.28	0.01	0.00*
Sec	.	.	.	.	.	0.00	0.00*	0.08	0.18	0.00*	0.00
G&E	.	.	.	.	.	.	0.41	0.00*	0.02	0.10	0.00*
S&F	.	.	.	.	.	.	.	0.00*	0.00	0.49	0.00*
Fash	.	.	.	.	.	.	.	.	0.00	0.00*	0.08
Life	.	.	.	.	.	.	.	.	.	0.00	0.00
Com	.	.	.	.	.	.	.	.	.	.	0.00*
Other	.	.	.	.	.	.	.	.	.	.	.

*p<0.00003

Table H 22. Domain Selection Comparisons for White Headband

	Ind	Med	H&W	Mili	Sec	G&E	S&F	Fash	Life	Com	Other
Ind	.	0.00*	0.00*	0.02	0.32	0.00	0.00*	0.10	0.03	0.00*	0.03
Med	.	.	0.00	0.00*	0.00*	0.00*	0.00*	0.00*	0.00*	0.00*	0.00*
H&W	.	.	.	0.00*	0.00*	0.00*	0.00*	0.00*	0.00*	0.00*	0.00*
Mili	.	.	.	.	0.25	0.16	0.00	0.00	0.85	0.00	0.00
Sec	.	.	.	.	.	0.01	0.00*	0.01	0.20	0.00*	0.00
G&E	.	.	.	.	.	.	0.02	0.00*	0.28	0.01	0.00*
S&F	.	.	.	.	.	.	.	0.00*	0.00	0.90	0.00*
Fash	.	.	.	.	.	.	.	.	0.00	0.00*	0.57
Life	.	.	.	.	.	.	.	.	.	0.00	0.00
Com	.	.	.	.	.	.	.	.	.	.	0.00*
Other	.	.	.	.	.	.	.	.	.	.	.

*p<0.00003

Table H 23. Domain Selection Comparisons for Purple Headband

	Ind	Med	H&W	Mili	Sec	G&E	S&F	Fash	Life	Com	Other
Ind	.	0.00*	0.00*	0.08	1.00	0.07	0.02	0.11	0.47	0.00	0.00
Med	.	.	0.00	0.00*	0.00*	0.00*	0.00*	0.00*	0.00*	0.00*	0.00*
H&W	.	.	.	0.00*	0.00*	0.00*	0.00*	0.00*	0.00*	0.00*	0.00*
Mili	.	.	.	.	0.06	0.85	0.46	0.00	0.03	0.17	0.00*
Sec	.	.	.	.	.	0.06	0.03	0.13	0.49	0.00	0.00
G&E	.	.	.	.	.	.	0.51	0.00	0.02	0.20	0.00*
S&F	.	.	.	.	.	.	.	0.00	0.00	0.65	0.00*
Fash	.	.	.	.	.	.	.	.	0.29	0.00*	0.00
Life	.	.	.	.	.	.	.	.	.	0.00	0.00
Com	.	.	.	.	.	.	.	.	.	.	0.00*
Other	.	.	.	.	.	.	.	.	.	.	.

*p<0.00003

Table H 24. Domain Selection Comparisons for Red Headband

	Ind	Med	H&W	Mili	Sec	G&E	S&F	Fash	Life	Com	Other
Ind	.	0.00*	0.00*	0.64	0.13	0.10	0.02	0.01	0.00	0.10	0.00*
Med	.	.	0.00*	0.00*	0.00*	0.00*	0.00*	0.00*	0.00*	0.00*	0.00*
H&W	.	.	.	0.00*	0.00*	0.00*	0.00*	0.00*	0.00*	0.00*	0.00*
Mili	.	.	.	.	0.35	0.04	0.00	0.04	0.58	0.04	0.00*
Sec	.	.	.	.	.	0.01	0.00	0.16	0.21	0.01	0.00
G&E	.	.	.	.	.	.	0.25	0.00	0.13	1.00	0.00*
S&F	.	.	.	.	.	.	.	0.00*	0.01	0.32	0.00*
Fash	.	.	.	.	.	.	.	.	0.00	0.00	0.00
Life	.	.	.	.	.	.	.	.	.	0.12	0.00*
Com	.	.	.	.	.	.	.	.	.	.	0.00*
Other	.	.	.	.	.	.	.	.	.	.	.

*p<0.00003

Table H 25. Domain Selection Comparisons for Pink Headband

	Ind	Med	H&W	Mili	Sec	G&E	S&F	Fash	Life	Com	Other
Ind	.	0.00*	0.00*	0.28	0.06	0.03	0.00	0.00	0.03	0.01	0.00
Med	.	.	0.00	0.00*	0.00*	0.00*	0.00*	0.00*	0.00*	0.00*	0.00*
H&W	.	.	.	0.00*	0.00*	0.00*	0.00*	0.00*	0.00*	0.00*	0.00*
Mili	.	.	.	.	0.47	0.00	0.00*	0.03	0.01	0.00	0.00
Sec	.	.	.	.	.	0.00	0.00*	0.13	0.00	0.00	0.00
G&E	.	.	.	.	.	.	0.05	0.00*	0.86	0.87	0.00*
S&F	.	.	.	.	.	.	.	0.00*	0.03	0.06	0.00*
Fash	.	.	.	.	.	.	.	.	0.00	0.00*	0.08
Life	.	.	.	.	.	.	.	.	.	0.73	0.00*
Com	.	.	.	.	.	.	.	.	.	.	0.00*
Other	.	.	.	.	.	.	.	.	.	.	.

*p<0.00003

Table H 26. Domain Selection Comparisons for Orange Headband

	Ind	Med	H&W	Mili	Sec	G&E	S&F	Fash	Life	Com	Other
Ind	.	0.00*	0.00*	0.12	0.62	0.07	0.00*	0.13	0.01	0.00	0.00
Med	.	.	0.00	0.00*	0.00*	0.00*	0.00*	0.00*	0.00*	0.00*	0.00*
H&W	.	.	.	0.00*	0.00*	0.00*	0.00*	0.00*	0.00*	0.00*	0.00*
Mili	.	.	.	.	0.20	0.71	0.00	0.00	0.44	0.03	0.00*
Sec	.	.	.	.	.	0.16	0.00	0.06	0.04	0.00	0.00
G&E	.	.	.	.	.	.	0.00	0.00	0.62	0.10	0.00*
S&F	.	.	.	.	.	.	.	0.00*	0.02	0.28	0.00*
Fash	.	.	.	.	.	.	.	.	0.00	0.00*	0.03
Life	.	.	.	.	.	.	.	.	.	0.29	0.00*
Com	.	.	.	.	.	.	.	.	.	.	0.00*
Other	.	.	.	.	.	.	.	.	.	.	.

*p<0.00003

Table H 27. Domain Selection Comparisons for Green Headband

	Ind	Med	H&W	Mili	Sec	G&E	S&F	Fash	Life	Com	Other
Ind	.	0.00*	0.00*	0.70	0.32	0.00	0.35	0.00	0.47	0.00	0.00*
Med	.	.	0.00	0.00*	0.00*	0.00*	0.00*	0.00*	0.00*	0.00*	0.00*
H&W	.	.	.	0.00*	0.00*	0.01	0.00*	0.00*	0.00*	0.01	0.00*
Mili	.	.	.	.	0.53	0.00	0.16	0.01	0.73	0.00	0.00*
Sec	.	.	.	.	.	0.00*	0.06	0.04	0.84	0.00	0.00
G&E	.	.	.	.	.	.	0.02	0.00*	0.00	0.87	0.00*
S&F	.	.	.	.	.	.	.	0.00	0.05	0.03	0.00*
Fash	.	.	.	.	.	.	.	.	0.02	0.00*	0.03
Life	.	.	.	.	.	.	.	.	.	0.00	0.00
Com	.	.	.	.	.	.	.	.	.	.	0.00*
Other	.	.	.	.	.	.	.	.	.	.	.

*p<0.00003

Table H 28. Domain Selection Comparisons for Blue Headband

	Ind	Med	H&W	Mili	Sec	G&E	S&F	Fash	Life	Com	Other
Ind	.	0.00*	0.00*	0.25	0.84	0.03	0.00	0.01	0.02	0.00*	0.00
Med	.	.	0.00*	0.00*	0.00*	0.00*	0.00*	0.00*	0.00*	0.00*	0.00*
H&W	.	.	.	0.00*	0.00*	0.00*	0.00*	0.00*	0.00*	0.00	0.00*
Mili	.	.	.	.	0.13	0.37	0.02	0.00	0.26	0.00*	0.00
Sec	.	.	.	.	.	0.03	0.00	0.02	0.02	0.00	0.00*
G&E	.	.	.	.	.	.	0.08	0.00	0.74	0.00	0.00
S&F	.	.	.	.	.	.	.	0.00*	0.13	0.48	0.00*
Fash	.	.	.	.	.	.	.	.	0.00*	0.00*	0.08
Life	.	.	.	.	.	.	.	.	.	0.03	0.00*
Com	.	.	.	.	.	.	.	.	.	.	0.00*
Other	.	.	.	.	.	.	.	.	.	.	.

*p<0.00003

Table H 29. Domain Selection Comparisons for Black Headband

	Ind	Med	H&W	Mili	Sec	G&E	S&F	Fash	Life	Com	Other
Ind	.	0.00*	0.00*	0.00	0.00	0.00*	0.00	0.52	0.81	0.00	0.01
Med	.	.	0.00*	0.00*	0.00*	0.00*	0.00*	0.00*	0.00*	0.00*	0.00*
H&W	.	.	.	0.00*	0.00*	0.00	0.00*	0.00*	0.00*	0.00*	0.00*
Mili	.	.	.	.	0.03	0.03	0.40	0.07	0.02	0.20	0.00*
Sec	.	.	.	.	.	0.00	0.01	1.00	0.64	0.00	0.00
G&E	.	.	.	.	.	.	0.29	0.00	0.00	0.50	0.00*
S&F	.	.	.	.	.	.	.	0.01	0.00	0.66	0.00*
Fash	.	.	.	.	.	.	.	.	0.66	0.00	0.00
Life	.	.	.	.	.	.	.	.	.	0.00	0.01
Com	.	.	.	.	.	.	.	.	.	.	0.00*
Other	.	.	.	.	.	.	.	.	.	.	.

*p<0.00003

Table H 30. Domain Selection Comparisons for Beige Headband

	Ind	Med	H&W	Mili	Sec	G&E	S&F	Fash	Life	Com	Other
Ind	.	0.00*	0.00*	0.06	0.21	0.02	0.02	0.37	0.18	0.00	0.00
Med	.	.	0.00	0.00*	0.00*	0.00*	0.00*	0.00*	0.00*	0.00*	0.00*
H&W	.	.	.	0.00*	0.00*	0.00*	0.00*	0.00*	0.00*	0.00*	0.00*
Mili	.	.	.	.	0.00	0.67	0.58	0.01	0.70	0.03	0.00
Sec	.	.	.	.	.	0.00	0.00	0.74	0.01	0.00*	0.05
G&E	.	.	.	.	.	.	0.85	0.00	0.47	0.09	0.00*
S&F	.	.	.	.	.	.	.	0.00	0.34	0.16	0.00*
Fash	.	.	.	.	.	.	.	.	0.03	0.00*	0.03
Life	.	.	.	.	.	.	.	.	.	0.02	0.00
Com	.	.	.	.	.	.	.	.	.	.	0.00*
Other	.	.	.	.	.	.	.	.	.	.	.

*p<0.00003

Appendix I

Color Comparisons between Product Top Domains

Table I 1. Color Comparisons for Activity Monitor: Medical Selection

	Yellow	White	Purple	Red	Pink	Orange	Green	Blue	Black	Beige
Yellow	.	0.20	0.51	0.03	0.52	0.12	0.13	0.33	0.86	0.16
White	.	.	0.06	0.39	0.55	0.01	0.80	0.78	0.15	0.90
Purple	.	.	.	0.01	0.20	0.38	0.03	0.10	0.64	0.04
Red	.	.	.	.	0.15	0.00	0.56	0.26	0.02	0.47
Pink	.	.	.	.	.	0.03	0.40	0.74	0.42	0.74
Orange	.	.	.	.	.	.	0.00	0.01	0.18	0.00
Green	.	.	.	.	.	.	.	0.60	0.10	0.90
Blue	.	.	.	.	.	.	.	.	0.25	0.68
Black	.	.	.	.	.	.	.	.	.	0.12
Beige	.	.	.	.	.	.	.	.	.	.

*p<0.00007

Table I 2. Color Comparisons for Activity Monitor: H&W Selection

	Yellow	White	Purple	Red	Pink	Orange	Green	Blue	Black	Beige
Yellow	.	0.12	0.34	0.06	0.10	0.95	0.23	0.02	0.94	0.77
White	.	.	0.55	0.73	0.90	0.11	0.73	0.40	0.11	0.20
Purple	.	.	.	0.34	0.47	0.31	0.80	0.15	0.31	0.50
Red	.	.	.	.	0.83	0.05	0.49	0.63	0.05	0.10
Pink	.	.	.	.	.	0.08	0.64	0.49	0.09	0.17
Orange	.	.	.	.	.	.	0.21	0.01	0.99	0.73
Green	.	.	.	.	.	.	.	0.24	0.21	0.36
Blue	.	.	.	.	.	.	.	.	0.02	0.04
Black	.	.	.	.	.	.	.	.	.	0.72
Beige	.	.	.	.	.	.	.	.	.	.

*p<0.00007

Table I 3. Color Comparisons for Activity Monitor Sports & Fitness Selection

	Yellow	White	Purple	Red	Pink	Orange	Green	Blue	Black	Beige
Yellow	.	0.55	0.02	0.29	0.48	0.07	0.21	0.83	0.75	0.08
White	.	.	0.08	0.65	0.91	0.23	0.51	0.70	0.36	0.25
Purple	.	.	.	0.19	0.10	0.57	0.28	0.03	0.01	0.52
Red	.	.	.	.	0.74	0.45	0.83	0.40	0.17	0.49
Pink	.	.	.	.	.	0.28	0.59	0.63	0.32	0.31
Orange	.	.	.	.	.	.	0.60	0.11	0.03	0.95
Green	.	.	.	.	.	.	.	0.30	0.12	0.65
Blue	.	.	.	.	.	.	.	.	0.60	0.13
Black	.	.	.	.	.	.	.	.	.	0.04
Beige	.	.	.	.	.	.	.	.	.	.

*p<0.00007

Table I 4. Color Comparisons for Activity Monitor: Lifestyle Selection

	Yellow	White	Purple	Red	Pink	Orange	Green	Blue	Black	Beige
Yellow	.	0.26	0.06	0.33	0.83	0.28	0.40	0.84	0.92	0.15
White	.	.	0.45	0.89	0.38	0.03	0.80	0.19	0.32	0.76
Purple	.	.	.	0.37	0.10	0.00	0.31	0.04	0.08	0.64
Red	.	.	.	.	0.46	0.04	0.91	0.24	0.39	0.66
Pink	.	.	.	.	.	0.21	0.54	0.69	0.91	0.24
Orange	.	.	.	.	.	.	0.06	0.39	0.25	0.01
Green	.	.	.	.	.	.	.	0.30	0.46	0.58
Blue	.	.	.	.	.	.	.	.	0.77	0.11
Black	.	.	.	.	.	.	.	.	.	0.19
Beige	.	.	.	.	.	.	.	.	.	.

*p<0.00007

Table I 5. Color Comparisons for Smart Glasses: Industry Selection

	Yellow	White	Purple	Red	Pink	Orange	Green	Blue	Black	Beige
Yellow	.	0.01	0.01	0.99	0.01	0.22	0.81	0.49	0.07	0.90
White	.	.	0.81	0.01	0.92	0.15	0.01	0.00	0.38	0.01
Purple	.	.	.	0.01	0.89	0.22	0.02	0.00	0.52	0.02
Red	.	.	.	.	0.01	0.21	0.81	0.48	0.07	0.91
Pink	.	.	.	.	.	0.18	0.02	0.00	0.44	0.01
Orange	.	.	.	.	.	.	0.31	0.05	0.57	0.26
Green	.	.	.	.	.	.	.	0.34	0.11	0.91
Blue	.	.	.	.	.	.	.	.	0.01	0.41
Black	.	.	.	.	.	.	.	.	.	0.09
Beige	.	.	.	.	.	.	.	.	.	.

*p<0.00007

Table I 6. Color Comparisons for Smart Glasses: Medical Selection

	Yellow	White	Purple	Red	Pink	Orange	Green	Blue	Black	Beige
Yellow	.	0.35	0.99	0.66	0.27	0.61	0.16	0.11	0.31	0.01
White	.	.	0.33	0.16	0.87	0.14	0.02	0.01	0.05	0.00
Purple	.	.	.	0.66	0.26	0.61	0.16	0.10	0.31	0.01
Red	.	.	.	.	0.12	0.94	0.33	0.23	0.56	0.02
Pink	.	.	.	.	.	0.11	0.01	0.01	0.03	0.00
Orange	.	.	.	.	.	.	0.37	0.26	0.61	0.03
Green	.	.	.	.	.	.	.	0.82	0.70	0.19
Blue	.	.	.	.	.	.	.	.	0.55	0.28
Black	.	.	.	.	.	.	.	.	.	0.09
Beige	.	.	.	.	.	.	.	.	.	.

*p<0.00007

Table I 7. Color Comparisons for Smart Glasses: Military Selection

	Yellow	White	Purple	Red	Pink	Orange	Green	Blue	Black	Beige
Yellow	.	0.05	0.01	0.61	0.02	0.58	0.24	0.37	0.76	0.58
White	.	.	0.61	0.14	0.70	0.15	0.42	0.28	0.09	0.15
Purple	.	.	.	0.05	0.91	0.05	0.18	0.11	0.03	0.05
Red	.	.	.	.	0.07	0.97	0.50	0.70	0.83	0.97
Pink	.	.	.	.	.	0.07	0.23	0.14	0.04	0.07
Orange	.	.	.	.	.	.	0.53	0.73	0.80	1.00
Green	.	.	.	.	.	.	.	0.78	0.38	0.53
Blue	.	.	.	.	.	.	.	.	0.56	0.74
Black	.	.	.	.	.	.	.	.	.	0.80
Beige	.	.	.	.	.	.	.	.	.	.

*p<0.00007

Table I 8. Color Comparisons for Smart Glasses: Security Selection

	Yellow	White	Purple	Red	Pink	Orange	Green	Blue	Black	Beige
Yellow	.	0.50	0.67	0.08	0.70	0.78	0.62	0.63	0.79	0.42
White	.	.	0.80	0.02	0.77	0.34	0.24	0.85	0.68	0.14
Purple	.	.	.	0.03	0.97	0.48	0.35	0.95	0.88	0.21
Red	.	.	.	.	0.03	0.14	0.21	0.03	0.05	0.36
Pink	.	.	.	.	.	0.51	0.38	0.92	0.91	0.23
Orange	.	.	.	.	.	.	0.83	0.44	0.58	0.59
Green	.	.	.	.	.	.	.	0.32	0.44	0.75
Blue	.	.	.	.	.	.	.	.	0.83	0.19
Black	.	.	.	.	.	.	.	.	.	0.28
Beige	.	.	.	.	.	.	.	.	.	.

*p<0.00007

Table I 9. Color Comparisons for Smart Glasses: G&E Selection

	Yellow	White	Purple	Red	Pink	Orange	Green	Blue	Black	Beige
Yellow	.	0.12	0.38	0.16	0.18	0.23	0.32	0.97	0.35	0.70
White	.	.	0.48	0.87	0.82	0.71	0.55	0.11	0.53	0.05
Purple	.	.	.	0.59	0.63	0.73	0.90	0.36	0.94	0.21
Red	.	.	.	.	0.95	0.84	0.67	0.15	0.64	0.07
Pink	.	.	.	.	.	0.89	0.72	0.17	0.69	0.09
Orange	.	.	.	.	.	.	0.82	0.21	0.79	0.11
Green	.	.	.	.	.	.	.	0.30	0.96	0.17
Blue	.	.	.	.	.	.	.	.	0.33	0.73
Black	.	.	.	.	.	.	.	.	.	0.18
Beige	.	.	.	.	.	.	.	.	.	.

*p<0.00007

Table I 10. Color Comparisons for Smart Glasses: Lifestyle Selection

	Yellow	White	Purple	Red	Pink	Orange	Green	Blue	Black	Beige
Yellow	.	0.00	0.02	0.25	0.00	0.07	0.09	0.01	0.04	0.10
White	.	.	0.21	0.02	0.98	0.07	0.06	0.34	0.13	0.05
Purple	.	.	.	0.23	0.22	0.59	0.51	0.78	0.77	0.48
Red	.	.	.	.	0.02	0.52	0.58	0.14	0.38	0.63
Pink	.	.	.	.	.	0.08	0.06	0.35	0.13	0.06
Orange	.	.	.	.	.	.	0.92	0.41	0.81	0.87
Green	.	.	.	.	.	.	.	0.35	0.73	0.95
Blue	.	.	.	.	.	.	.	.	0.57	0.33
Black	.	.	.	.	.	.	.	.	.	0.69
Beige	.	.	.	.	.	.	.	.	.	.

*p<0.00007

Table I 11. Color Comparisons for Smart Glasses: Communication Selection

	Yellow	White	Purple	Red	Pink	Orange	Green	Blue	Black	Beige
Yellow	.	0.05	0.57	0.54	0.20	0.20	0.03	0.07	0.04	0.74
White	.	.	0.14	0.16	0.48	0.47	0.85	0.85	0.97	0.09
Purple	.	.	.	0.95	0.46	0.46	0.10	0.20	0.13	0.82
Red	.	.	.	.	0.50	0.50	0.11	0.23	0.15	0.78
Pink	.	.	.	.	.	1.00	0.37	0.60	0.46	0.34
Orange	.	.	.	.	.	.	0.36	0.60	0.45	0.34
Green	.	.	.	.	.	.	.	0.71	0.88	0.06
Blue	.	.	.	.	.	.	.	.	0.82	0.14
Black	.	.	.	.	.	.	.	.	.	0.09
Beige	.	.	.	.	.	.	.	.	.	.

*p<0.00007

Table I 12. Color Comparisons for Headband: Medical Selection

	Yellow	White	Purple	Red	Pink	Orange	Green	Blue	Black	Beige
Yellow	.	0.21	0.76	0.35	0.46	0.59	0.04	0.92	0.89	0.06
White	.	.	0.35	0.74	0.59	0.07	0.00	0.23	0.17	0.52
Purple	.	.	.	0.54	0.68	0.41	0.02	0.83	0.67	0.12
Red	.	.	.	.	0.84	0.14	0.00	0.39	0.30	0.34
Pink	.	.	.	.	.	0.20	0.01	0.52	0.39	0.24
Orange	.	.	.	.	.	.	0.14	0.52	0.70	0.02
Green	.	.	.	.	.	.	.	0.03	0.07	0.00
Blue	.	.	.	.	.	.	.	.	0.82	0.07
Black	.	.	.	.	.	.	.	.	.	0.05
Beige	.	.	.	.	.	.	.	.	.	.

*p<0.00007

Table I 13. Color Comparisons for Headband: H&W Selection

	Yellow	White	Purple	Red	Pink	Orange	Green	Blue	Black	Beige
Yellow	.	0.31	0.76	0.90	0.32	0.91	0.34	0.27	0.49	0.09
White	.	.	0.49	0.37	0.98	0.25	0.05	0.03	0.09	0.48
Purple	.	.	.	0.85	0.50	0.67	0.22	0.16	0.32	0.17
Red	.	.	.	.	0.39	0.81	0.28	0.22	0.41	0.11
Pink	.	.	.	.	.	0.26	0.05	0.03	0.09	0.47
Orange	.	.	.	.	.	.	0.41	0.32	0.56	0.07
Green	.	.	.	.	.	.	.	0.89	0.81	0.01
Blue	.	.	.	.	.	.	.	.	0.70	0.00
Black	.	.	.	.	.	.	.	.	.	0.02
Beige	.	.	.	.	.	.	.	.	.	.

*p<0.00007

Table I 14. Color Comparisons for Headband: G&E Selection

	Yellow	White	Purple	Red	Pink	Orange	Green	Blue	Black	Beige
Yellow	.	0.46	0.92	0.84	0.91	0.27	0.03	0.43	0.21	0.15
White	.	.	0.53	0.34	0.39	0.73	0.00	0.96	0.05	0.49
Purple	.	.	.	0.76	0.83	0.33	0.02	0.50	0.18	0.20
Red	.	.	.	.	0.93	0.19	0.05	0.32	0.30	0.10
Pink	.	.	.	.	.	0.22	0.04	0.36	0.26	0.12
Orange	.	.	.	.	.	.	0.00	0.76	0.02	0.73
Green	.	.	.	.	.	.	.	0.00	0.35	0.00
Blue	.	.	.	.	.	.	.	.	0.04	0.51
Black	.	.	.	.	.	.	.	.	.	0.01
Beige	.	.	.	.	.	.	.	.	.	.

*p<0.00007

Table I 15. Color Comparisons for Headband: S&F Selection

	Yellow	White	Purple	Red	Pink	Orange	Green	Blue	Black	Beige
Yellow	.	0.47	0.85	0.63	0.15	0.42	0.35	0.85	0.62	0.05
White	.	.	0.38	0.81	0.48	0.92	0.10	0.59	0.23	0.01
Purple	.	.	.	0.51	0.11	0.33	0.47	0.71	0.76	0.08
Red	.	.	.	.	0.35	0.74	0.16	0.76	0.34	0.02
Pink	.	.	.	.	.	0.54	0.02	0.21	0.06	0.00
Orange	.	.	.	.	.	.	0.08	0.52	0.20	0.01
Green	.	.	.	.	.	.	.	0.26	0.67	0.31
Blue	.	.	.	.	.	.	.	.	0.50	0.03
Black	.	.	.	.	.	.	.	.	.	0.15
Beige	.	.	.	.	.	.	.	.	.	.

*p<0.00007

Table I 16. Color Comparisons for Headband: Communication Selection

	Yellow	White	Purple	Red	Pink	Orange	Green	Blue	Black	Beige
Yellow	.	0.92	0.69	0.23	0.25	0.34	0.49	0.78	0.48	0.24
White	.	.	0.76	0.28	0.30	0.39	0.43	0.71	0.55	0.28
Purple	.	.	.	0.45	0.48	0.59	0.28	0.50	0.77	0.45
Red	.	.	.	.	0.96	0.82	0.06	0.14	0.64	1.00
Pink	.	.	.	.	.	0.86	0.07	0.15	0.68	0.96
Orange	.	.	.	.	.	.	0.10	0.21	0.81	0.82
Green	.	.	.	.	.	.	.	0.66	0.17	0.07
Blue	.	.	.	.	.	.	.	.	0.33	0.14
Black	.	.	.	.	.	.	.	.	.	0.65
Beige	.	.	.	.	.	.	.	.	.	.

*p<0.00007