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Insights into the role of gender in aesthetic design: a participatory study on the design of digital health wearables

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Abstract

The role of artificial intelligence (AI) in facilitating the real-time processing of data is revolutionising the future of healthcare through mobile diagnostics, remote monitoring devices, and wearable technology products. The rise in digital wearables for remote healthcare is evolving at an increasing pace towards patient-centred and personalised care with connected patients. This transformation is creating new opportunities for designers to increase patients' participation and sustain their engagement in remote healthcare. In this paper, the authors have investigated the role of gender in aesthetic design in the context of digital health wearables to enhance user engagement and interaction. The investigations were conducted through participatory design sessions and showed a constructive relationship between aesthetic preferences and understanding the influence of gender as a means of facilitating user engagement with digital health wearables. This paper presents a novel user response model that leads to suggestions for future work, including research in the areas of gender awareness in aesthetics to move beyond traditional, stereotypical, and pre-identified gendered characteristics related to femininity and masculinity. The findings conclude with a path forwards for design research to promote gender awareness in aesthetic design for the realisation of healthcare wearables of the future.

Keywords Aesthetics · Gender · Remote healthcare · Digital health wearables · Participatory design

1 Introduction

The rise in the number of people living with long-term conditions and the cost-effectiveness of technology-enabled care services (TECS) have driven a major market growth towards remote healthcare wearables for patients, carers, and healthcare professionals [1]. Also, recent technological advancements in digital wearables transforming healthcare delivery especially in rural and remote areas. This pattern is accelerating to reduce healthcare costs as users are becoming more independent in the monitoring and self-management of their health [2]. This has led to a significant shift in digital health monitoring so that the biggest technology companies such as Google and Phillips have been developing digital wearables with flexible sensors in garments. Their partnerships with hospitals and pharmaceutical companies have shifted the market growth towards the rapid progress of personal health platforms through digital wearables for diagnosis, treatment, patient-self monitoring, and prevention. However, the NHS Institute for Innovation and Improvement stated: "Despite the strong official commitment to developing a patient-led service, our results suggest the UK is not performing well when it comes to involving patients in their care" [3]. One of the identified current challenges within the context of digital wearables for healthcare is the role of patients to take an active part in their healthcare [3].

To promote patients' engagement and participation in their healthcare, facilitating a better interaction between patients and digital wearables is of great importance. However, current digital wearables are often technology-driven without the involvement of the end-user [2]. The current studies in the area of digital wearables for healthcare are primarily focused on the design from the technology end or healthcare provider end [4]. The role of digital wearables is crucial in the transformation of distinct patient engagement

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in monitoring their health data. An important dimension of successful patient-device interaction is associated with the aesthetic aspects related to qualities that appear in the physical properties of digital wearable devices. The goal of this paper is to explore the role of gender in aesthetic preferences in the context of digital health wearables to enhance user engagement.

Interactive wearable technology is a central hub to remote healthcare linking personal devices such as mobile phones, smartwatches, and fitness trackers to the external environment for remote healthcare [5]. Many popular brands such as Apple, Amazon, and Samsung offer a range of smartwatches and fitness trackers that monitor and display a range of health informatics including daily step count, calories, heart rate, and sleep quality. Fitness trackers and smartwatches are currently designed to be worn around the wrist as a bracelet and as clip-on trackers. However, a displacement of the sensor around the wrist and lack of direct contact with the skin is a potential limitation for tracking heart rate. A number of challenges associated with inaccurate readings due to improper device placement limits effectiveness for older adults with movement disorders such as Parkinson's disease and epileptic seizures. These limitations suggest the lack of inclusivity in the design of smartwatches for user diversity [6].

In Sect. 2, a detailed discussion of the human-centred design (HCD) in facilitating user engagement is discussed. It is followed by exploring the role of gender and proposing the combination of aesthetics and understanding gender performances as a model for enhanced interaction in Sect. 3. In Sect. 4, we explain the deployed participatory design sessions to investigate the role of gender in digital wearables and how it can be used as a means of facilitating user engagement. Subsequently, in Sect. 5, we discuss the results and conclude our discussions in Sect. 6 by outlining the role of gender to encourage active participation in remote healthcare. Finally, Sect. 7 presents new avenues and opportunities for future research in the fields of interaction design and health promotion.

2 Design

Design is a powerful tool for addressing challenges in the area of digital wearables for healthcare today, by recognising the opportunities to provide a human-centred experience [7]. An integral role of design in improving digital wearables for healthcare starts with understanding and influencing the experience of patients for enhanced management of their healthcare remotely [2]. The triangle formed by design agencies, technology companies, and healthcare service providers, drives the current healthcare transformation globally [8]. Currently, the contribution of global design companies such

as IDEO is towards personalised and patient-centred healthcare services using the human-centred design approach [2]. In 2014, Apple launched a health informatics mobile app called *Health Kit* that enables users to monitor and share their health information such as health conditions, medications, and allergies. Similarly, Google has developed personal health monitoring platforms for health and activity tracking. Also, Philips is focused on technological healthcare innovations that meet the end-user needs mainly by improving the user experience. Another important aspect of understanding the patient experience is related to patient safety rules under the US Food and Drug Administration (FDA) obligation [9]. There is an increasing concern over the potential risks for the patients along with the technological advancement in healthcare systems [10]. To minimise such risks, the integration of the Human-Centred Design (HCD) approach is required to optimise the user interaction with digital wearables towards self-management of healthcare [1]. HCD is a creative approach to problem-solving [11] that prioritises understanding human needs to develop products, services, and systems that are understandable, usable and desirable for people [12].

Over time, HCD has shifted its emphasis from human interaction and user experience with objects and machines towards human interaction with the world, i.e. how people perceive the knowledge in the world that forms meanings and experiences [13]. This is evident through the progression of HCD from the field of human factors/ergonomics initially towards interaction, usability, and user experience design [14].

2.1 User experience, interaction design, and aesthetics

User experience (UX) is described as "a result of a motivated action in a certain context [13]". According to Norman, the faults and errors when using a product are not upon human action but it is the design problem through the lack of understanding human needs. This means every error in interacting with a product is a fault in the design linked with the lack of communication [12].

HCD is a process that starts with establishing an appreciation of people's behaviour to enhance user experience with interactive and non-interactive systems, products, and services. The principles of interaction design provide an understanding of meanings in human interactions with an interactive product. The interpretation of our interactions forms our experiences as enjoyable or frustrating. As a result, designing effective interactions between people and products is crucial in improving the user experience. The field of *interaction design* focuses on understanding and enhancing the interactions between people and products,

aiming to replace frustration and confusion with pleasure and enjoyment in such interactions [12].

Since the advent of computers, *interactivity* has been a pivotal aspect of the design of all computer-related products. In fact, interactivity can be considered as the basic competitive advantage of such products. *Conversation* is the most common form of interactivity that we experience; that is why Crawford has defined interactivity—using the familiar context of a conversation—as "*a cyclic process in which two actors alternately listen, think, and speak*", where the quality of interaction is determined by the quality of its subtasks, i.e. listening, thinking, and speaking. In the context of human–computer interaction (HCI), these three subtasks are considered as metaphors representing *inputting*, *processing*, and *outputting*, respectively [15]. These model can be also adapted to the field of human–robot interaction (HRI), where robots can be evaluated based on the quality of their interactions with human users [16, 17].

As a formal discipline, interaction design is at least partially a subset of user experience (UX) design, with partial overlaps with industrial design, graphic design, and human factors. The disciplines surrounding interaction design are depicted on the left-hand side of Fig. 1 [18].

Unquestionably, aesthetics is a major consideration in various design-related disciplines such as industrial design, architecture, sound design, UX design, and human factors engineering [19–23]. From a different perspective, aesthetics is one of the main subfields of philosophy, with other major subfields being logic, metaphysics, epistemology, and ethics, as illustrated on the right-hand side of Fig. 1. Here we have attempted to map aesthetics as a subfield of the latter to the context of the former. As depicted in this figure, aesthetics has connections with various design-related disciplines.

2.2 Human action

The following discusses Norman's guideline for overall stages of human action to understand how people interact with an object and how their actions are formed. In this manner, two main concepts are introduced when user interacting with a physical object based on how to execute an action and the evaluation of the performed actions. According to Norman, in the context of using an object, people face the two stages by firstly how to use it that represents discoverability as *how I know what I'm doing* and secondly *what happened*. These two concepts are coined in the field of psychology as the *gulf of execution* and the *gulf of evaluation* by E. Hutchins and J. Hollan [12]. In this context, human actions are divided into two-stage of execution and evaluation. Norman has suggested a simplified model for overall stages of human
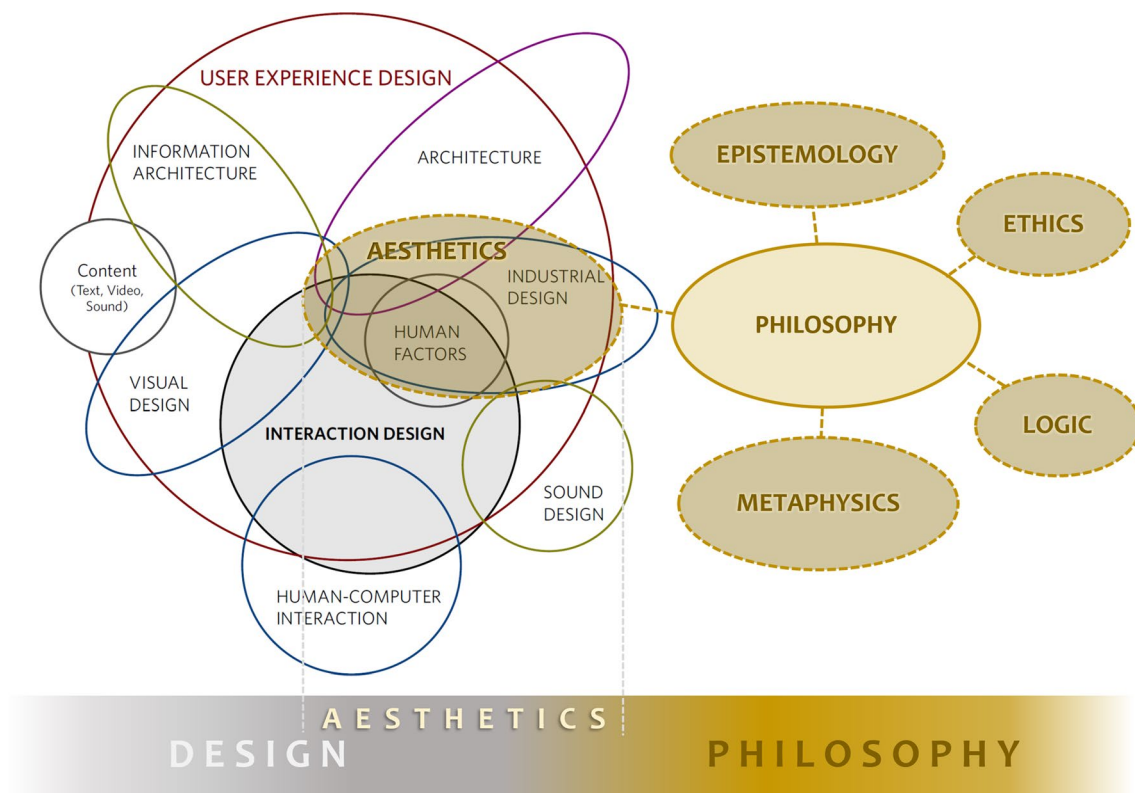
Fig. 1 Aesthetics as a subfield of philosophy mapped onto the context of design, including interaction design and its sister disciplines (the relationship between interaction design and its sister disciplines is adapted from [18])

action that provides a guideline for designers to understand human action in the context of an interaction between a product and a person. This model consists of seven stages of human action that help designers bridge the gap between the gulf of execution and the gulf of evaluation to achieve their intended goals. In this model, most human actions require a similar sequence of activities for execution. Furthermore, this model shows the possible actions to achieve the main goal to perform an action. On this basis, Norman introduces a model that guides further understanding of human actions and behaviour through the exploration of different levels of the human mind's information processing based on cognition and emotion [24]. Cognition is the perception and the mental action or process of acquiring knowledge, and emotion is the feelings and experiences which according to Norman are the most important factors for designers to design products, objects, and systems that are usable, understandable and desirable.

As shown in Fig. 2a, Norman describes how products stem user response through three main levels of information processing in achieving the intended goals. According to Norman [12], the terms *user response* is related to the interpretation of the product by the human mind's information processing. There are three levels of information processing (Fig. 2b) categorised into visceral, behavioural, and reflective levels based on cognition and emotion [12]. The visceral level is linked to emotions and features quick and subconscious responses in novel situations without awareness or control. Visceral responses are the immediate perception of enjoyment with no concern about the usability and understanding of the product.

On the other hand, the behavioural level is based on emotion and cognition that each action is weighed against the perceived expectations and feedback. This level is critical as it aligns the actions with the expectations to achieve the goal. The reflective level is the highest level that entails human cognition and is based on our conscious actions from the goal. There is a deep understanding, reasoning, and conscious decision-making taking place at the reflective level. A lot of analysis takes place at this level since it is slow, in-depth, and cognitive. The reflective level is placed in planning a goal and the outcome. However, the behavioural level is based on our perception and expectations and the lowest level is the visceral level that is concerned with the sequence of action and perceiving the available knowledge from the world.

Norman describes the interaction between the user and a physical object through the HCD principles such as *affordances* and *signifiers* based on the branches of psychology [12]. He relates these terms based on the interpretation of how an object is perceivable to define the possible actions for interaction based on the physical characteristics of a product such as colour, material, and form which act as signifiers to show how users can interact with the objects. He also described the concept of affordances and signifiers as perceivable cues related to our interpretation and our past knowledge and experiences applied to our perception. Both aesthetics and affordances are considered to be crucial to provide effective ways of interaction, leading to product success [25]. Norman discusses extensively the role of aesthetics in design which can lead to improved usability and user experience.

The differences in the perceived use of products based on the stated principles of aesthetics referred to as the *product language* in marketing inspired by Gros in 1976 [26]. Product language is widely used as an important factor to expand market growth by embedding traditional gender stereotypes in products [27]. However, further understanding of product language that relates those two important aspects of aesthetic design and gender is mostly underexplored from the design research perspective.

The relationship between design and gender has a long history from critical gender perspectives centred on gender power relations embedded implicitly in product language

Fig. 2 **a** The basic model of user response to product [24] **b** Norman's seven stages of action and three stages of processing [12]
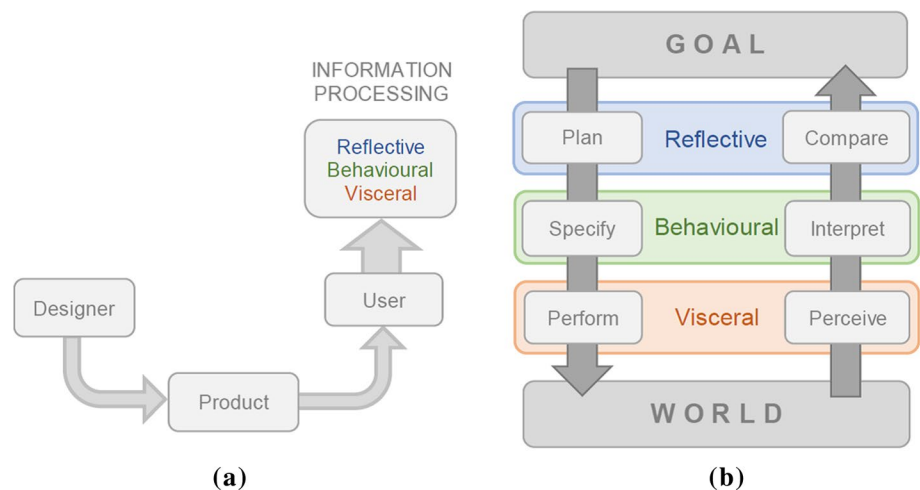
[28]. This debate has grown in importance in light of recent consideration to avoid gender inequalities embedded in the characteristics of products. In recent years, products that are targeted at both male and female genders are advertised as unisex (gender-neutral), and some of the most popular companies such as Apple focus specifically on unisex products, e.g., the Apple Watch. The key feature of unisex products is related to identical visual and physical properties such as colour, material and shape advertised for both men and women. However, the stated characteristics in products are only considered as gender-neutral where the gender of design is invisible [28]. In contrast, products targeted towards the male gender or female gender take account of stereotypical gender norms in the product properties. This type of product language continues to result in producing designs that highlight the differences in products characteristics such as *pink for girls* and *blue for boys* [27].

Such design considerations related to stereotypical gender norms can be seen in male-targeted and female-targeted cosmetic products, e.g., in Dove, Nivea, and Gillette razors. In 2006, Jahnke focused on visualising gender perspectives in product categories through embedded marketing strategies in an exhibition called *Formgivning/Normgivning*. This exhibition displayed a range of products from automotive safety design based on men's body measurements to heavy industry clothing designed based on stereotypical gender norms in society [26].

Currently, the shift towards gender diversity and gender-neutral products are growing in the leading brand companies. However, the language embedded in such products is evoked and interpreted as normative and gendered [27]. For example, the product line of the Apple Watch is designed for men and women by Marc Newson, one of the leading designers worldwide famous for non-gender specific products [29]. Similarly, Karim Rashid is a famous designer with a gender-neutral brand identity towards "design should be for everyone". He attempts to minimise gender differences in his designs, for both male and female genders [30]. One of his successful designs is the Bobble water bottle in various colours to filter tap water. His design has contributed to multiple leading brands for everyday products such as Alessi targeting gender-neutral designs. For example, a very popular kettle by Alessi was designed by Michael Groves in 1985 with a specific shape and material design for both genders. However, a range of critical gender studies argues invisible meanings and values in the language of gender-neutral products according to the traditional male or female domain [31]. It seems that a critical gender perspective and its role in product language has not so far been widely incorporated in design research. A critical perspective on gender as a social construction and not a given fixed concept is underexplored in design research.

3 Gender

The followings illustrate why gender is important from the viewpoints of three key theorists of gender with a background in psychosocial and cultural studies. Harriet Bradley defines gender as "the relations between women and men" [32]. According to Bradley, gender is persistent; everything from TV programs to car designs is gendered artefacts. Gender is described as the cultural definitions of masculinity or femininity and the power between men and women that are not stable and fixed, but it develops over time in interaction with cultural and social values [32]. Masculinity and femininity are the core theme of understanding stereotypical gender norms defined by Connell as an endorsement of traditional attitudes and behaviour that is socially constructed [33].

As a result, masculinity and femininity are constructed around specific cultural and social norms linked with gender inequalities in society. Therefore, the root of masculinity and femininity is formed through the gender differences associated with the social and cultural impacts in the society related to being male or female [32]. Gender refers to the relations between men and women associated with social and cultural differences. In line with the debates concerning gender by Harriet Bradley, Frosh et al. [34] discuss the idea that the construction of gender is not biological or genetically formed but is a set of performative acts or actively *doing gender* with a relational nature.

The concept of gender has been challenged and widely used as social constructionism. This means we perform our gender all the time through our gender roles and acting to present our gender to the world in ways such as clothing, ideology, actions, and words. Therefore, gender is culturally formed under the norms of society produced over time through our behaviours, performing being a man or woman.

Frosh et al. [34] drew upon the work of gender theorist J. Butler and described gender as a set of performative acts. They acknowledged that there are multiple modes of masculinity, or approved modes of *being a man*, that are socially-constructed and open to reconstructions in different contexts. They argued that "masculinities are made into, and lived as, natural or essential identities [34]". Overall, masculinity is a performative act; gender is a performance, and it changes in relation to our interactions and the respective context. On the other hand, the HCD fundamental model describes the user response based on a broad understanding of the shared values and common actions of all people. As illustrated in Fig. 2, Norman holds the view that despite the given variations and experience that affects individuals, fundamentally the user response is based on three levels of information processing approach in the human mind. Based on this model, the interpretation of product language related

to the aesthetic qualities of products can be predictable on many occasions. However, gender is performed and enacted over time through our interactions. This can be seen particularly in the dynamic and fluid patterns of our behaviour over time [32].

The construct of gender stereotypes is derived from the normative gender roles that are changing over time. This means the changes in the social roles of men and women and beliefs for new roles in society shapes and influences the stereotypical gender norms. For example, men redefine their masculinities over time and express themselves in relation to their masculine roles, identities and behaviours that give access to design opportunities for products, services and brands. In this manner, masculinities play a major role in marketing men's products. The dominance of hegemonic masculinity is apparent in men designed products that implies constructing the concepts opposite to femininity. In addition to the absence of gender in design as a set of performative acts, the existing models of understanding user response lack the role of gender-related to the aesthetic interpretation of the user.

In this paper, the investigation was conducted through participatory design sessions and highlighted a constructive relationship between aesthetics and understanding the influence of gender as a means of facilitating user engagement.

4 Methods

4.1 Participatory design sessions

Participatory design sessions were deployed with novice designers to investigate the influence of gender in aesthetic preferences such as the forms, colours, and materials as a means of facilitating user engagement with digital wearables.

This study included two key stages: (1) the product language exploration stage, and (2) the design stage. For this study, a range of commonly used smartwatches, advertised for male and female genders, were considered to explore the role of gender in aesthetic interpretations by the participants. The participatory design approach requires small groups of participants based on the nature of participation for focused and in-depth results [35]. A total of two groups, with three participants for a male-only group and a female-only group, included product design students from the University of East London took part in this study on 23/10/2019. The main criteria for participants' selection were based on their gender and educational/professional status as novice designers. Each session was approximately 30 min and followed the same structure. The different dynamics of a male-only group, as opposed to a female-only, provides an opportunity to compare the group dynamics linked with the participants' enactment of gender roles [34] and their interaction with a range of popular smartwatches available in the market. The difference between the female-only group and the male-only group revealed similarities by both male and female participants, while aspects of their interactions were observed in relation to their gender.

4.2 Stage one: product language

Initially, the participants sat around a table while printed images of the most commonly used smartwatches targeted at men and women by Fitbit, Fossil, Samsung and Apple were presented to them (Figs. 3 and 4). The participants were asked to share their opinions and interests with regard to the visual and physical characteristics of the smartwatches illustrated below.

In addition, this study explored the participants' interpretation related to gender patterns portrayed in the

Fig. 3 From left to right: Fitbit, Fossil, Samsung and Apple smartwatches targeted at men [36] (the product photos are printed with all rights reserved)

Fig. 4 From left to right: Fitbit, Fossil, Samsung and Apple smartwatches targeted at women[37] (the product photos are printed with all rights reserved)
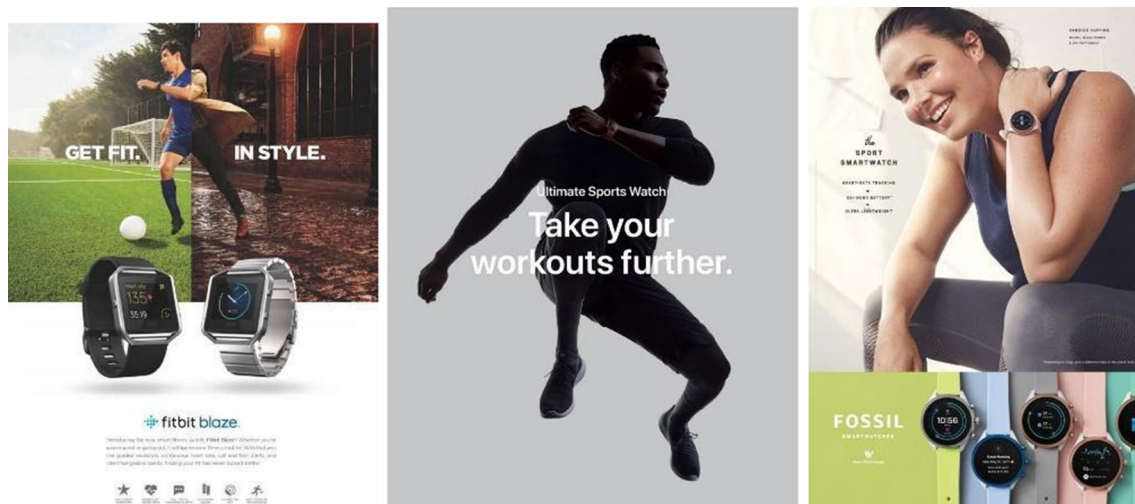
Fig. 5 From left to right: Fitbit, Apple, and Fossil smartwatch advertisements [36] (the product photos are printed with all rights reserved)

advertisements for the illustrated smartwatches (Fig. 5). Various leading brands such as Apple, Fitbit and Fossil have embedded masculine or feminine attributes in male-targeted and female-targeted advertisements. Such advertisements portray patterns that feature specific gender subjects focused on the stereotypical differences in male and female gender roles [38].

4.3 Stage two: design

The final stage of this study facilitated through co-design techniques such as ideation and brainstorming to increase the participants' engagement and participation while empowering them as designers. The participants were guided to express their ideas and design new smartwatches through a range of materials for brainstorming including tools for sketching, utensils, pen and papers, whiteboards, coloured markers. The following illustrate each design outcome and highlights the participants' description in their words. This is followed by a discussion particularly

focussing on the key elements of affordances, signifiers and gender identified in each design outcome. So far, we have focused on the key theories necessary to explain the course of analysis for the design outcomes. To achieve this, the following discusses and analyses the design outcomes guided by the following structure. All design outcomes are analysed through an adopted structured analysis process: *describe*, *analyse*, and *assess* [39]. We first *describe* the design outcomes individually followed by the participants' discussion of their design in their own words. Second, we *analyse* the design outcome using a deductive approach guided by the theories of HCD and gender. Third, we draw on the *assessment* of the results in the context of design insights.

4.3.1 Group one (female-only)

Describe The following outcomes illustrated below is designed by three female participants. As the participants
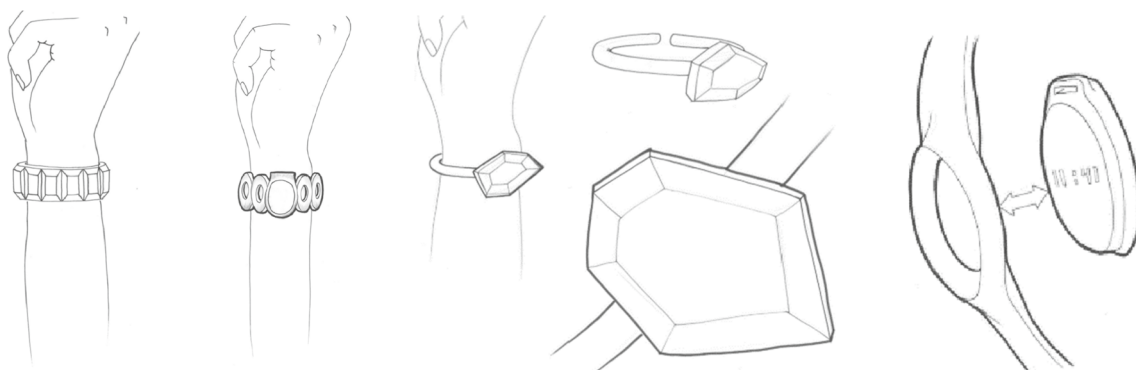
Fig. 6 The images of designed concepts by three female participants (author's photograph)

said: *"our design is a smartwatch in the form of a bracelet for men and women"*.

Analyse In the participants' words, their design outcomes are similar to women's bracelet. This means the female participants portrayed their interests and motives influenced by their gender experience with some degree of familiarity. Their design portrays a similar object that is designed for women associated with the culturally established and feminine characteristic. As illustrated in Fig. 6, the overall form of this concept is rounded with curved lines driven by the participants' experience. The participants' gender contributed to the physical characteristics and attributes of the affordances and signifiers that emerged in their design. From the HCD perspective, the affordances in this design are rounded and the characteristic signifies wearability. These characteristics show similarities with bracelets targeted at women featuring thin straps, organic, and rounded shape. In contrast, often men's products are characterised by complex, angular shapes, and dark colours [27]. Moss relates the use of visual aesthetics in products that differ in terms of shape, colour and material associated with the perception of culturally established male and female gender roles in society. Also, the same expectations follow how the product will be used. Examples of such designs are gender-specific shaving razors for men and women that differ in terms of shape, colour and material [26]. For example, the bright coloured razors are designed specifically for women through specific characteristics including soft, rounded, and organic shapes. In this context, colour suggests the use of razors targeted at men or women [38]. This shows how the participants' reflections are informed upon expressing their gendered experiences related to their own gender identity provoked by their designs.

Assess The emerged attributes expressed by the female participants are similar to the particular characteristics of popular products for everyday use targeted at women. This association reveals their motivation identified in the language of affordances and signifiers in a way that is according to their own experience. Up to this point, the comparison of these results pinpoints the significant role of gender in relation to the design outcomes and the participants' gender perceptions. This evidence suggests the participants' gendered enactments are traced and characterised in the design of affordances and signifiers.

4.3.2 Group two (male-only)

Describe The next design outcomes illustrated below are designed by three male participants. As the participants' said: "this is a smartwatch similar to my current watch with a black leather and silver strap".

Analyse The participants said the physical appearance of their design is similar to the appearance of their watch (Fig. 7). Similarly, the male participants in the first stage of the study showed interest in colours of silver and black and referred to these colours as masculine. Also, various leading cosmetic brands and advertisements such as DOVE MEN feature silver-coloured attributes in their designs [40]. These representations are mainly focused on stereotypical and culturally established associated with the meanings of industrial, sleek, high-tech, and modern [27].

For the male participants, the aesthetic attributes such as colour and material are interpreted as masculine associated with the ways hegemonic masculinity is expressed. Their gendered reflection is related to conform to pre-identified gender roles from using their everyday things such as their cosmetic products reflected in the design of the affordances and signifiers. The design outcomes demonstrate some variations by the participants in the male-only group and the female-only group. This is related to the ways gender enactment are expressed align with the participants' gender roles. We can see the participants performing their gender implicitly which has influenced the physical appearance of the design outcomes. The characteristics of their design are central to maintain gender boundaries as a way of expressing their masculinity.

Assess The participants own interpretation of the affordances and signifiers are gendered in their language and shows the need for the awareness of their needs related to their masculinity. This suggests the link between the

Fig. 7 The images of designed concepts by three male participants (authors' photograph)
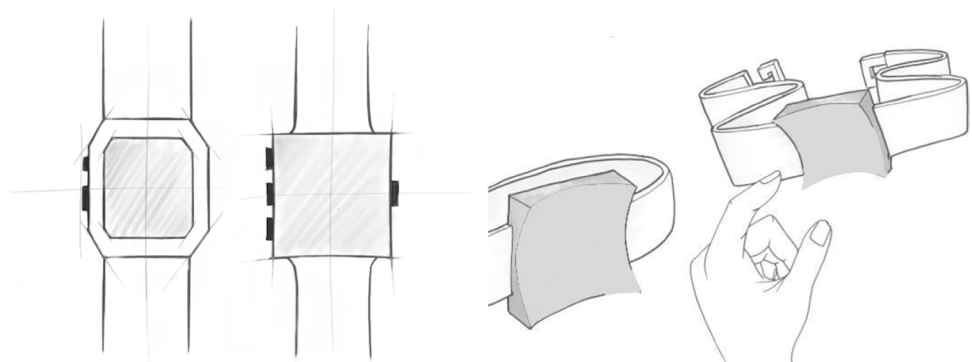
current products and their advertisements for men that portrays gendered characteristics and its reflection in the participants' perceptions. It is noticeable from the appearance of the illustrated design how the main features of affordances and signifiers are inspired and applied in their design based on the participant's gender. The emerging meanings that they attach to the products associated with their gender are consistently based on the gender stereotypes of being like other men and women.

5 Key themes

The following section overviews the key themes that emerged from the analysis and interpretation of the data obtained from the participatory sessions. The main findings from the analysed data suggest the commonly recurring patterns in the expression of gender and the dominant discourses of masculinity in connection with identifying the meanings, motivations, and experiences of the participants in relation to the interpretation of the aesthetic qualities. The following themes portray the ways the participants seem to be concerned with *being* like others [41]. Their responses came across as their fear of being seen different as it seems they want to be accepted by being like others.

5.1 Theme 1: gendered aesthetics

All the female participants expressed their interest in smartwatches which were targeted towards their gender. In particular, they identified the main characteristics of products such as colours, shapes, and materials associated with masculine and feminine characteristics. However, they identified a range of features and meanings attached to the products as familiar, which were important considerations for them when buying and using smartwatches. All the male participants associated the product language aligned with their gender roles. Also, they associated the outlined smartwatches targeted at their gender through stereotypical colours such as *pink for girls* and *blue for boys*. All male participants said they avoided using products that are not designed for their gender. This is an important consideration for the male participants which shows their interest in products targeted at their gender. Appendix 1 presents a few examples of the way they described their unwillingness in using products that are not designed towards their gender.

The female participants identified colours as being associated with specific genders, and the forms of products as being gendered. They identified the Apple Watch, advertised as a gender-neutral product, to be masculine.

Importantly, they believed that the gender-neutral products seemed more masculine, identifying specific features such as large square screens and wide straps in silver to be linked with the male gender. Examples of comments by male participants are given in Appendix 2.

In comparison, the male participants also identify specific colours as gendered and consciously attach gendered values to the products. Although, the female participants' attitudes seem freer and more open to the rules and norms of appropriate behaviour but also more engaged in more variety of interests than the male participants. It is recognisable from the female respondents, that the way they attach meaning seems free and more flexible than the male participants in using specific products.

The male participants showed interest in the Apple Watch because of the silver-coloured strap. They also said that all the products available in the market for men are usually grey or black with metal textured straps which will not get damaged. It seems silver and dark colours such as black means macho/masculine to them. Also, they expressed their awareness of dark colours as a stereotypical colour designed for men described based on the characteristics of popular cosmetic products among young men. This indicates the male participants prefer products aligned with their gender roles and the construction of their masculinity. These characteristics, such as colour, are related to the previous experiences of the participants linked with the ways in which the product language is perceived in relation to masculinity and femininity. The male participants were interested in a material that is not vulnerable or easily damageable; this is attached with the construction of masculinity through being strong. Therefore, the silver-coloured straps attached masculine elements to the product, result in increasing their confidence. Example comments from the participants are given in Appendix 3.

Both male and female participants associated colours with a particular gender: dark colours to the male gender, and bright colours to the female gender. Their preferences seemed to be associated with gender imperatives and concerns about the rules and norms of appropriate behaviour and gender stereotypes; this demonstrated the hidden influences of advertising and marketing which affect the social shaping of masculinity.

The stated differences in the visual and physical properties of the outlined products such as form, material, and colour signify the link with masculine or feminine attributes embedded in the language of affordances and signifiers towards a specific gender. All participants said that the outlined smartwatches seemed more masculine, with male participants identifying specific features such as sharp edges, i.e. square-shaped screens, and dark coloured straps such as grey and black to be more appealing to male participants. The variations in the male participants' responses outlined above in comparison with those of the female participants

indicated that their gender differences created and reacted in their responses associated with displaying patterns of masculinity or femininity. At this point, we should note that all the male participants expressed views and ideas associated with masculinity. As the male participants said, their motivations and reasons to use products not designed for their gender refer back to their fragility of masculinity. This analysis also indicated that understanding of how the male participants express their concern related to the fragility of masculinity [34] which emphasizes the importance of protecting their gender roles based on their interpretation of aesthetic qualities in product language.

5.1.1 Theme 2: *Masculinity*

The participants also indicated various forms of asserting their masculinity through the outlined advertisements in Fig. 3. All male participants said the demonstrated advertisements have basic and fewer details. As they explained, gender-targeted advertisements for men incorporate minimal information; it does not take too long to read the details, look more rigid, and using infographics to convey information visually means it takes less time for the user to read the details. The findings suggest a reflection of the participants' interpretation related to their perceptions derived from their gender identity and the norms of society. These attributes could be influenced and contributed by the social expectations in society, such as the pressure they receive from their peers and parents to perform their traditional gender roles [42]. For example, Gillette's marketing campaign uses images of football players for advertising the shaving experience for men. The marketing campaigns use the reflection of a *successful* man in the mirror and create a perception that every male consumer can acquire a similar image. The combination of these approaches motivates competitiveness to attract men by using associations with sports, strength, competitiveness, heterosexual orientation and dominance which tend to impersonate hegemonic masculinity in men [42]. In particular, a masculine lifestyle implies being involved in sports, and as a consequence, athletic body shape prevails in relation to the level of self-esteem and heterosexuality. An athletic body shape as a muscular body contributes to a positive perspective to young males as being masculine to express their difference from femininity [33]. From this analysis, fear of being seen as homosexual is one of the main reasons for the way young males present themselves towards the stereotypical ways of being like other men.

6 Discussion and conclusions

The results highlight a constructive relationship in the role of gender and aesthetics, thus opening new avenues and knowledge paths to bridge the gap between the world of designers and the world of users. As discussed in the previous section, the participants' gender identity influences their aesthetic interpretation based on the appearance of products, including affordances and signifiers. The reoccurring emphasis on the perceived aesthetics of smartwatches targeted at men showed a clear preference of the male participants towards maintaining their masculine identity. Their preferences towards the aesthetic characteristics of popular male-targeted cosmetic products. In addition, the participants' explanations of their preferences were related to their interpretation of aesthetics including product properties such as chunky shapes, dark colours, and metal-looking materials.

The finding shows how the male participants' values are connected to each product language associated with the masculine attributes portrayed to enact their gender roles and masculinity. In this context, the aesthetics guide the user to understand how to interact with an object based on the designers' gendered perceptions associated with traditional male or female gender roles. In addition, the designers' perceptions imbricated in aesthetics through affordances and signifiers, interpreted by the user, can contradict the participants' gender identity. As discussed earlier, the participants' responses show the product language will not necessarily be perceived by the user, as designers intended. The male participants repeatedly referred to the gender-neutral products as not masculine based on their interpretation of product properties such as curvy lines coming across as feminine. This is particularly based on their perception of masculine attributes and provides evidence regarding their preferences.

This shows a gap between the user needs in line with their gender in specific contexts and specific interactions in relation to aesthetic interpretation by users. Although the gender-neutral products are targeted at both male and female users, the aesthetics based on designers' perceptions leads to stereotypical product language perceived to one gender only.

The current products advertised as gender-neutral and gender-specific must embed gender-awareness in the design of aesthetics with regard to the perceptions of the specific user, not the designer. This means going beyond stereotypical gender norms linked with strong masculine or feminine product language. The inclusion of gender may affect aesthetic interpretations beyond stereotypical gender norms by increasing awareness related to the designers' gender.

The existing model of Norman's user response supports a broad understanding of human action in interpreting a product; however, it does not support the role of gender-related to a user response. The expanded model illustrated in Fig. 8

Fig. 8 Expanded model for user response to gender-neutral and gender-specific products
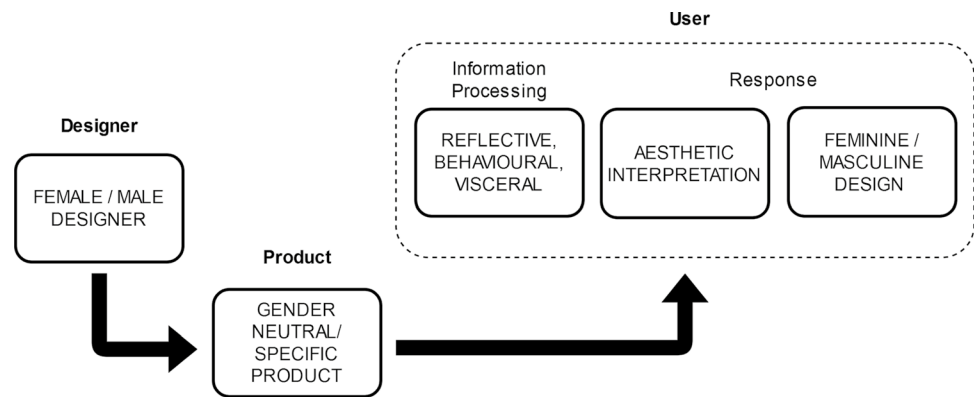
presents the importance of gender awareness related to aesthetic interpretation in user response.

Apart from the user response, this model goes beyond the aim of the research; it also portrays the role of the designers' gender leading to how products are designed and perceived as masculine or feminine designs. This means the aesthetic interpretations are subjective to the designer and the user gender. This model assists the designers in ways their gender is reflected and perceived by the user in both aesthetics and affordances. Aesthetics may also influence the user response to design, evoking masculine and feminine attributes, whether or not the designers intended. These references that moderate user response is added above (Fig. 8) may be interpreted between the product language (gender-neutral or gender-specific) itself and the gender of the user.

Furthermore, beyond increasing awareness for the designers, it may also influence the product language, whether male-targeted, female-targeted, or gender-neutral, that may result aligned with the gender of the user. In conclusion, this paper investigated the link between gender and aesthetic concerning the interpretation of perceived affordances and their relation to the user's gender for digital wearables. This analysis goes beyond the aim of this paper and contributes towards understanding the way that gender, being a male or female designer, affects the designer's perceptions.

7 Implications for future research

This paper could open new avenues for future research in the following directions: (1) using gender-aware aesthetics in the design of digital wearables to improve health-related behaviours, and (2) considering the role of gender-aware aesthetics for the wider design community. This could consist of design research and practice to increase the emphasis on the importance of gender, helping to support and encourage gender awareness to enhance patients' engagement with digital wearables. Based on participants' feedback discussed, designers' awareness of the influence of their gendered

perceptions in aesthetic design is a starting point. The lack of gender awareness neglects the user's needs to be addressed as it is a crucial element of how the product is established as human-centred and to sustain and promote user engagement for healthcare. The design community should consider moving away from normative gender stereotypes when developing new designs in terms of the gender identity of the user that are socially constructed in different contexts. This could guide designers to a closer understanding of barriers in front of patients in managing their health remotely.

In conclusion, our suggestion for the design and healthcare research communities is to be aware that designers' gender identity plays a key role in influencing affordances and signifiers, which emerge in a range of physical features of design such as lines, material, shapes, and colours. The implication of raising gender awareness in aesthetic design can result in addressing the gap between the worlds of designers and users. Bridging this gap requires designers to go beyond their gender perceptions and focus on the users' gender identities. Also, making the role of gender visible in designers' perceptions broadens the design of digital wearables beyond the stereotypical perceptions of gender. Taking this approach will move designers to consider aesthetics design in new and innovative ways, and this could have considerable implications in digital health wearables. In addition, the implication of gender awareness in aesthetics should be considered for the realisation of future wearables to influence health-related behaviours associated with preventative risks factors such as Tobacco use, obesity, and alcohol misuse [43]. The Department of Health of the United Kingdom encourages the design of new interventions and programs particularly in health promotion to stop the annual increase of incidence and mortality rates by changing attitudes and behaviours. With this in mind, desirable changes in health-related behaviours lead to the reduction of health incidence rates, therefore, less crowded health care services, and reduced subsequent costs.

Appendix 1

The following demonstrates a few examples of comments by female participants. As anonymity and confidentiality of participants are central to this research, the participants are named based on their gender and role in this article (*M* = male respondent; *F* = female respondent; *No.* = Age):

[F, 23]: I do not mind using products that are designed for men, but Apple Watch looks too masculine because of the large square screen and a wide silver strap.

[F, 21]: I prefer dark colours and smartwatches that are not rounded and curvy; I like them to be chunky with sharp edges - with mixed materials like wood and grey aluminium.

[F, 23]: I also agree that metal will not get damaged easily and I feel more confident wearing it every day.

[F, 23]: Clunky straps look more masculine, appropriate for big forearms and wrists - as large smartwatches like Apple Watch are manlier.

Appendix 2

Example comments of male participants were as follows (*M* = male respondent; *No.* = Age):

[M, 19]: I do not like smartwatches that are rounded and too soft like the Apple Watch, I prefer those with a straight line and huge screens.

[M, 25]: I prefer the silver-coloured strap on the Apple Watch, which has an aluminium finish that does not get damaged.

[M, 22]: I agree that the normal metal textured straps look very good and durable. Also, the brighter colours are more feminine, and smartwatches with a bigger screen and wider straps are for men.

[M, 20]: Rounded products are feminine, and products with sharp edges are masculine with aggressive lines and more approachable.

Appendix 3

Example comments by designers were as follows (*M* = male respondent; *F* = female respondent; *ND* = novice designer; *ED* = experienced designer):

[M, ND]: I buy products that are dark coloured such as black, grey, and are for men similar to my DOVE MEN body spray and shower gel if a product is designed for women, it will have bright colours such as white, tan, or rose gold

[M, ED]: Products for men are dark blue and black, female products are curvy, and I usually buy products that are dark colours and are for men, the screen has straight lines or as a square.

[M, ED]: Men's products are dark coloured such as Nivea Men products that are blue, and women's products are pink and white

[M, ED]: I always buy men's products because it is important to me.

[M, ND]: There is no way I wear a feminine watch. Also, I do not like watches with bright colours; they are cool, but I will buy them for my girlfriend, not for myself.

[M, ND]: Most people will think you are weird if you use a female product.

[M, ED]: I do not wear thin watches because of thin straps and a rounded screen. Also, men's smartwatches look rigid, large, and hefty.

Declarations

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