Towards a Framework for Designing Socially Acceptable Wearables for Well-being

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1 Introduction

Many wearables for well-being have been developed, both commercially and by researchers [1–5, 8, 9]. For those commercially available and widely used, their designs highlight few different patterns in how they look and function (e.g., [1–5]; Figure 1), compared to those that have been proposed in research (e.g., [8, 9]; Figure 2). The existing commercial designs demonstrate only a small subset of design possibilities for how a wearable can look, function, and be used (e.g., mimicking jewelry-like forms and integrating subtle, haptic feedback; see Figure 1).

Social acceptability of a wearable is defined as having an absence of negative reactions or judgments from others [7]. By definition, the form and function of the wearable determine how individuals perceive how socially acceptable it is. Although the commercial wearables seem socially acceptable based on their wide adoption, we know little about how designs that do not fit the more narrow design space (e.g., watches, rings, and eyeglasses) impact social acceptability.

Figure 1: A set of existing, widely-used commercial wearables: a) Apple Watch [1], b) Ray-ban Meta glasses [4], c) Oura Ring [3], d) Garmin Active Watch [2], e) Whoop Band [5].

From social acceptability literature, little guidance exists for designing socially acceptable wearables [7]. Most recently, a set of four strategies have been proposed by Koelle et al.:

(1) Subtlety, Unobtrusiveness, & Avoiding Negative Attention
(2) Avoiding Suggestiveness & Misinterpretation
(3) Accessory-like Shapes & Familiar Styles
(4) Candidness, Transparency, & Justification

However, these strategies are high-level, and implicitly reinforce the narrow design space demonstrated by the commercial forms. For example, all devices take on common, minimal accessory or jewelry-like forms. This leaves designers and researchers without guidance for how less common wearable forms, such as etextiles, can be designed to be socially acceptable. This knowledge gap is particularly important to learn about given the recent growth of wearables that adopt different form factors and functionality, such as smart textiles, and embodied computing [6].

As a starting point for understanding social acceptability for wearables that take on different forms and functions, we look to our prior research on bespoke wearables that highlight examples of different aspects of device form and function than the aforementioned commercial examples. These examples, although would not be obviously classified as socially acceptable per the proposed strategies, were still deemed socially acceptable by the participants who proposed those designs. Through these examples, we:

(1) Demonstrate how the existing strategies may not cover a broad range of socially acceptable wearable designs; and
(2) Contribute an early design framework that helps expand the scope of these design strategies by providing more specific metrics for consideration.

This workshop paper aims to provoke discussion about how social acceptability in wearable design might be conceptualized as a flexible, spectrum-based design space wherein a series of stylistic form-, function-, and perception-related metrics are considered. By exploring such adjustable dimensions, we seek to expand the range of wearable forms that are considered socially acceptable, both in well-being contexts and beyond.

2 Designing for Social Acceptability

The social acceptability design strategies proposed by Koelle et al. [7] offer high-level considerations related to device form, function and perception broadly. The first strategy, *subtlety, unobtrusiveness, and avoiding negative attention*, encourages designers to evaluate how discrete a wearable is, and whether it draws unwanted attention. The second strategy, *avoiding suggestiveness and misinterpretation* encourages critical consideration of where bystanders might misunderstand or misread a device, its signals, and its purpose. The third strategy, *accessory-like shapes and familiar styles*, encourages designers to consider whether wearables resemble familiar accessories that match users' styles and identities, to avoid drawing unwarranted attention. The fourth and final strategy, *candidness, transparency, and justification*, encourages designers to determine how a device communicates its purpose to both, the wearer and its bystanders.

These strategies, while a useful starting point, risk limiting the design of socially acceptable wearables into a narrow set of familiar, subtle forms, thereby constraining the exploration of alternative but still acceptable designs. In the next section, we elaborate on the similarities and design patterns the commercial devices share. We then consider alternative wearable forms that would push the boundaries of the socially acceptable commercial wearables for well-being that exist today.

3 Comparing and Contrasting the Social Acceptability of Standard and Alternative Wearable Designs

When considering the five examples pictured in Figure 1, which we call *standard wearable designs*, they exhibit a number of similarities. For example, they all mimic accessories that are normalized and have been used for decades without technology-integrations (Strategy 3), they all collect data in ways that are unknown to bystanders who may not be aware of the device's abilities (Strategies 1 and 2), and they are all subtle in how they communicate with the user (Strategy 1). Because these devices primarily operate through passive sensing and private feedback, they rarely require justification or transparency towards bystanders (Strategy 4). Of this set, the Apple Watch pushes these boundaries the most, due to its support for touch interactions, customizable watchface visuals, and integrated audio capabilities [1].

In constrast, alternative designs, as shown in Figure 2, don't neatly match the proposed design strategies. However, they could still be perceived as socially acceptable. Thus, we look to our prior research on bespoke wearables to consider alternative examples of wearables for well-being. Through these examples, we highlight how variations in a number of device characteristics relative to device form, function, and perception might be incorporated to extend the possibilities of what wearables for well-being could look like, while remaining socially acceptable. Differing from Koelle et al.'s proposed design strategies [7], we explore the concept of social acceptability as emerging from a series of adjustable characteristics in relation to wearable design.

3.1 Alternative Examples

We consider four unique examples from our prior research: a purse-based glucose monitor [8], a hairclip-based glucose monitor [8], a colour-changing t-shirt [9], and an illuminating dress [9] (see Figure 2). These designs were proposed and deemed socially acceptable by participants in our prior research [8, 9]. We first briefly describe these examples, and then shift our focus to breakdown how they represent the aforementioned design metrics.

Purse-based Glucose Monitor. The first example, Figure 2a, is a glucose monitor in the form of a cross-body purse. It receives data readings from a connected body-inserted sensor and provides feedback alerts to the user in three ways: a blinking light on the front flap, an audio alert, and an exact numerical reading under the purse's flap. This design was meant to be noticeable by bystanders as a monitoring technology, but its feedback was only meant to be understandable to the user.

Hairclip-based Glucose Monitor. The second example, Figure 2b, is a glucose monitor in the form of a hairclip. It receives data readings from a connected body-inserted sensor and provides haptic feedback alerts to the user which are felt on the back of their head. This design was meant to be entirely private, with bystanders not being able to recognize it was a technological device.

Figure 2: A set of participant-deemed socially acceptable wearables for well-being that we consider: a) a purse glucose monitor that lights up, provides an audio alert, and exact numerical readings of blood glucose levels; b) a hairclip glucose monitor that vibrates to inform the user a new reading has been taken and is available to view on their partner application; c) an informative colour-changing tshirt that lights up based on proximity to others to showcase potential spread of viruses; and d) a lit-up dress to draw attention and convey awareness about an ongoing concern.

Colour-changing T-shirt. The third example, Figure 2c, is a tshirt that displays data about the spread of COVID-19. The shirt is lined with LEDs, and activates when another person comes into close proximity with the wearer. Upon close interaction, the LEDs shine, demonstrating the potential risk of contraction the wearer faced.

Illuminating Dress. The fourth example, Figure 2d, is a dress that was initially designed to create awareness about wildfires and climate change. The dress is made up of cigarette butts, and is lined with LEDs that flicker warm hues representative of a flame. While this design was initially brainstormed in an application outside well-being, its design and interactive elements can be reconsidered towards a well-being oriented use case.

We focus on this subset of examples to consider alternative forms of wearables that employ the aforementioned patterns in different manners. We pay particular attention to: alternative *on-body placement locations*, different *modalities of feedback*, *neutrality* in devices, and changing *audiences* for feedback, interactions, and device purposes. By analyzing these characteristics, we identify dimensions of wearable design that influence social acceptability while expanding the space previously defined by Koelle et al. [7].

Across these examples, we observe that social acceptability emerges through a combination of many metrics. In Figure 3 we categorize and summarize these characteristics based on how each of our four identified examples operationalizes them. Below, we describe each of these dimensions and illustrate the broader design space they encompass.

Characteristics	Purse	Hairclip	T-shirt	Dress
On-body Placement Location	Side/Off-body	Head	Torso	Torso/Arms/Legs
Feedback Modality	Audio, Visual	Haptic	Visual	Visual
Level of Abstraction	Exact, Understandable to others	Abstract	Abstract	Either
Neutrality	Neutral	Neutral	Expressive	Expressive
Visibility	Semi-public	Private	Public	Public
Device Purpose Awareness	Ambiguous or Signalling	Obscured	Transparent	Signalling

Figure 3: A comparison of the four unique wearables we consider from our prior research.

3.1.1 On-body placement. On-body placement refers to where on the body a device is situated, and how that placement aligns with common locations for garments and accessories to exist on a person.

As shown in Figure 1, commercial devices often occupy conventional accessory locations on the body (e.g., wrist, fingers, and face). In contrast, our examples emphasize integrations onto garments worn on the torso (e.g., shirts and dresses), or on other unconventional, yet common accessory zones (e.g., purses and hairclips). This demonstrates that while Strategy 3 holds, wherein familiar, accessory-like shapes are utilized for creating wearables that are deemed socially acceptable, participants were open to alternative placements than those most commonly associated with existing, widely-used commercial wearables. This suggests that Strategy 3 could be extended to encapsulate more than currently interpreted: familiarity can encompass diverse garment forms in addition to accessories and jewelry-like devices.

3.1.2 Feedback modality. Feedback modality refers to the ways in which a device communicates alerts or information to others, specifically, what senses it activates.

Commercial wearables often rely on haptic feedback in order to remain subtle and unobtrusive in user's daily lives, thereby matching Strategy #1. In our examples, however, we observed participants exploring other feedback modalities, such as sounds, lights, and visuals. Surprisingly, sometimes participants wanted these forms of feedback to be intentionally visible or audible to those around them.

Participants valued visual feedback in the forms of colour-changing clothing and lit-up clothing for reasons such as expressiveness, creating or sharing awareness, and engaging bystanders [9]. Audio and multi-sensory feedback, on the other hand, were desirable for reasons such as triggering multiple senses, flagging urgency, enabling shared understandings or responsibility, and maintaining flexible use across contexts [8].

These understandings suggest that feedback does not need to remain subtle, unobtrusive, or private in order to be considered socially acceptable, extending Strategy #1. Desirable feedback modality can differ across context, intent, and audience, and therefore, preferences can change depending on a user's surroundings. Therefore, we speculate that feedback modality is categorical, comprising of at least four distinct states: audio, visual, haptic, and tactile.

3.1.3 Neutrality. Neutrality refers to how much the wearable blends into its social surroundings versus attracting deliberate attention through its design, whether via its form or function.

Commercial wearables often aim for aesthetic neutrality, so as to remain discrete and hidden in their surroundings, and to attract a wider autdience base. In contrast, our participant examples, namely the illuminated dress, intentionally tried to garner attention and conversation from those in their surroundings [9]. It is important to note that in this instance, such attention-seeking was aligned with the designer's goals and expressiveness, and therefore deemed appropriate rather than socially unacceptable.

This suggests that social acceptability does not always require minimizing wearables, their visibility, and their interactions, contradicting Strategy #1. Instead, acceptability may depend on whether or not the attention drawn from or to the wearable is contextually appropriate and aligned with the wearer's intent. Therefore, we suggest that neutrality exists on a spectrum which ranges from inconspicuous, private, or discrete, to expressive and public, wherein attention is intentionally drawn to the wearable.

3.1.4 Audience. Audience refers to who the device is intended to inform and engage, as well as who is meant to understand the device's purpose and feedback.

As shown in Figure 1, commercial devices typically are private devices and therefore only inform and engage with the wearers only, maintaining a high level of privacy. Across our examples, we observed that audience can be broken into two unique, yet related metrics: *feedback visibility*, e.g., who the actuation or output is noticeable to; and *device purpose awareness*, e.g., how much bystanders are aware of what the device is doing and why.

In our set of four examples, we noticed patterns emerge between the use cases of the devices. Those that were meant to be more expressive (e.g., t-shirt and dress) looked towards more public social engagement and awareness [9]. The glucose monitor designs, on the other hand, were targeted more towards private, or selectively chosen audiences [8].

These observations suggest that social acceptability relies on the relationship the device user has with their environments, bystanders, and the device's utility, combining and extending Strategy #1, #2 and #4. Therefore, we posit audience as two individual characteristics — feedback visibility and device purpose awareness — wherein both metrics range over spectrums encapsulating how understandable the device's feedback, communications, interactions, and purpose are to those around them.

4 Towards a Framework

Building on the metrics of placement, modality, neutrality, and audience, we propose an early framework for designing socially acceptable wearables for well-being, and beyond (see Figure 4). Through these efforts, we do not intend to replace the existing design strategies for social acceptability [7], but rather complement and extend them by reframing social acceptability through adjustable, individual device characteristics.

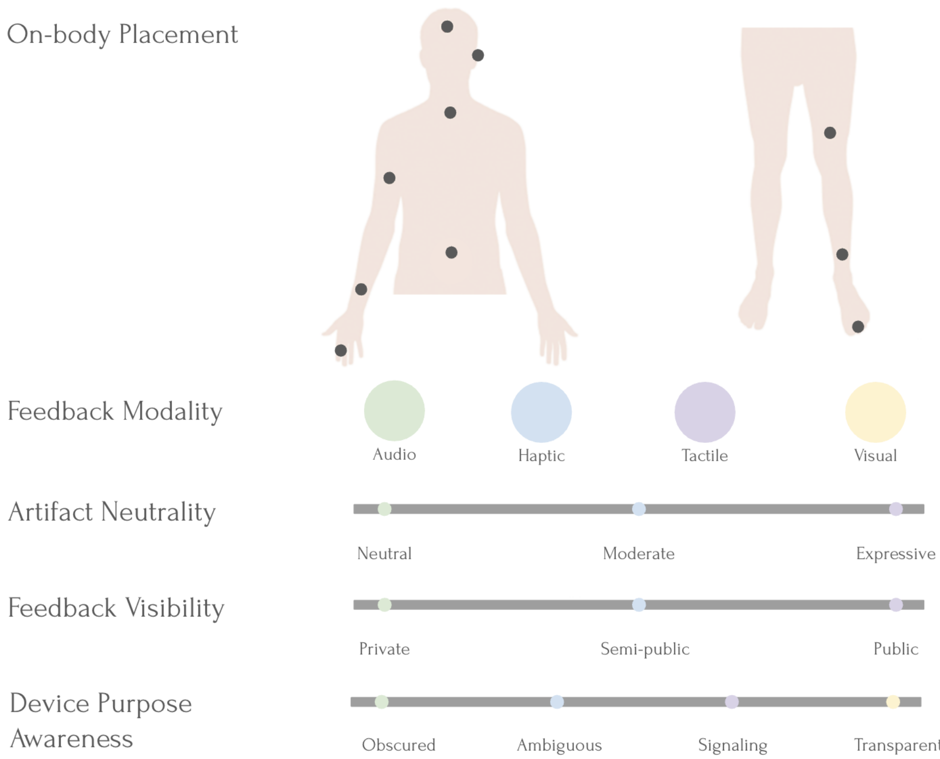

Figure 4: An early conceptualization of a framework encompassing key design metrics and the spectrums they may have.

While the previously discussed design strategies emphasize high-level principles like subtlety and familiarity, our proposed framework conceptualizes social acceptability as a concept that is made up of a series of nuanced design decisions which exist across spectrums. We reconsider social acceptability as a negotiated outcome that results from a series of deliberate decisions across numerous device dimensions and characteristics.

In the future, we think designers can utilize such a framework to deliberately position a device across varied combinations of these individual dimensional spectrums — for instance, by increasing expressive, incorporating more public feedback, or exploring unconventional on-body locations — while still maintaining utility and contextual appropriateness. A designer could, for example, intentionally increase feedback visibility while preserving aesthetic neutrality to create a health monitoring device that is expressive, yet non-intrusive and non-disruptive.

This framework's purpose, at this time, is to support exploration of how unconventional well-being wearable forms might achieve social acceptability through intentional alternate design choices in relation to device form, function, and perception.

5 Future Work

As we continue working on development of this framework, we envision two main next steps: 1) adding more refined metrics relative to device form, function, and perception that can help concretely define intermediate stages of stylistic changes to enhance devices and their social acceptability; and 2) considering such a framework through the lens of Koelle et al.'s [7] design strategies to consolidate our extension of their principles with the initial design strategies to which they may relate.

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