
What can Doodles on the Arm teach us about On-Body Interaction?

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Abstract

The use of the skin as interaction surface is gaining popularity in the HCI community. To offer an alternative perspective on how we might design on-body interactions, we conducted a questionnaire asking if, how, and why people mark their skin. We found that visibility and ease of access were important factors for choosing to mark the body. We also found that while some participants consider marking the body as a private activity, most participants perceive such markings as a public display. This tension between the personal nature of on-body interaction and the skin as a public display, as well as hedonic uses of body markings, present interesting design challenges.

Author Keywords

Skin interaction; On-Body Interaction

ACM Classification Keywords

H.5.m. Information interfaces and presentation (e.g., HCI): Miscellaneous

Introduction

In recent years, researchers have published many systems and investigations dealing with interaction on the body. Such projects include on-body projection [15-17], on-body touch-gestures, touch sensing on the body [25,30,36,41,42] and explorations of imaginary on-body interfaces [7,12,39,40].



Figure 1 - Engineering students in Canada dyeing their body purple for their first week at university. This reinforces their identity as engineering students and makes them easily recognizable for each other and others.

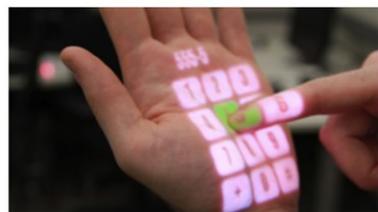
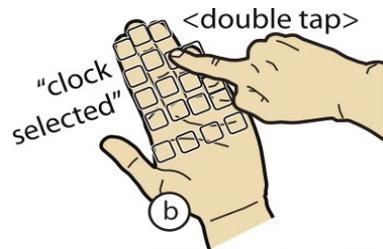


Figure 2 - Top: GUI-Like Interactions using an 'imaginary phone' [11]: the user is navigating between different applications, receiving acoustic feedback. Bottom: implementation of on-body dial-pad [13].

Interacting with the skin is not something new or unique to this trend in HCI. Since early human culture, we have used the body as an interactive medium for markings for religious, cultural, or medical purposes [8]. Such markings are recorded in various statuettes [18] and have been found on ancient mummies [5]. Body markings have been an important element in many cultures up to this day [3].

Contemporary body markings take on various forms, such as make-up or body modifications. Other examples include sports fans painting their face to express support for their team, eye-black worn by athletes [32], high school undergraduates marking themselves to establish a shared identity (Figure 1), or simply a parent writing their phone number on the hand of their child at a busy event [9]. Current research into on-body interaction, however, does not support such applications. Instead it seems to be focused on transferring interactions from devices onto skin. For example, researchers have suggested literally imagining one's hand to be a smartphone, or adopting applications and interactions methods typically used in GUIs to interactions on body (Figure 2) [11,16].

We suggest that looking at how we mark our body can serve as a source of input for the design of on-body-interactions. To better understand the breadth of different ways in which people mark their body, we created a questionnaire that allowed open ended answers. We present an analysis of these answers and use them to formulate recommendations related to the design of on-body systems. Results indicate that on-body interactions have their distinct affordances: for example, interaction methods we are accustomed to from mobile devices might not support the sense of

immediacy people have when marking their body. Designers must also deal with the tension created by the personal nature of interaction on the body and that the skin is considered a public interface.

Related Work

One of the earliest examples of functional tattoos dates back more than 5000 years ago [5]. Ötzi, a mummy found in the Austrian Alps, had 61 distinct tattoos, apparently non-ornamental [31]. These tattoos were believed to have medical properties. They were interactive in the sense that they were created with the expectation of causing a physical reaction in the body [8]. Recently, designers have explored the ideas of interactive tattoos and body markings that are immediately reactive. These works range from speculative technologies [1] to Photoshop hacks [44], CGI exploration [34] and beauty technology [10,38] (Figure 3). A large body of HCI research explores sensing through and with the body. For example, both Personal Area Nets by Zimmermann [43] and Rekimoto's GesturePad [33] use the body as an electrical medium, conducting pico currents for communication between devices through the body, or using the body's capacitive properties for touch detection. An inspirational system for many was Harrison's Skinput, which used acoustic sensing for determining tapping locations on the body [17]. This was followed up by a series of explorations of touch sensing on the skin using acoustic [23,27,37], near infrared (IR) [20,25,28,30,36], capacitive [26,41] and computer vision based systems [13,16,24,40].

Arguments for on-body systems include that a) they are more socially appropriate than speech interfaces and ergonomically better than gestural interfaces [6];



Figure 3 - Katia Vega's 'beauty technologies' explore extending the interactive potential of the body. A common theme in her work is that, like with our bodies, not all of the interactions can be consciously controlled [10,38].

b) skin provides a larger interaction surface than mobile devices [42]; c) the skin provides tactile feedback to users through their own body [29] as well as d) appeals to muscle memory, hand-eye coordination and knowing ones' body 'like the back of one's hand' [13,16,17,21]. We intend our work to provide a clearer rationale of when to use (and not use) on-body interactions.

Study Rationale & Questionnaire Design

We defined body marking to be "*all non-permanent marking except for 'cosmetic make-up'*". We chose this definition because we expect content of on-body technologies to be interactive, and were thus interested in spontaneous and in-situ actions. The questionnaire first asked for basic demographic information as well as how often participants marked their body. The remaining questions were designed to elicit descriptions of body marking behaviors in general terms. We provided participants with a large textbox to answer with as much detail as they wished. We asked the following questions: *In which situations do you find yourself marking your body? Why do you draw on or mark your body? What is it that you would typically mark on your body? Where on the body do you place your markings? Have you ever marked someone else's body, do others mark your body?*

Participants

We created English and Spanish versions of the questionnaire and posted them to our personal Facebook networks and Reddit. We recruited 108 participants aged 15 to 84 ($M = 28$, $SD = 10$). 26 participants identified themselves as male, 76 as female and 6 participants did not specify either. 43 participants were from Europe, 29 from North America,

30 from South America. 28 people answered the questionnaire in Spanish; their answers were translated into English for analysis. 15 people stated they 'never' mark their body. The remaining 93 stated that they at least 'rarely' mark their body—18 of them stating they do it 'often'.

Data Analysis Method

We collected 540 free-form quotes. We used an *affinity diagram* [19] to organize these quotes in thematically related groups, so as to find meaningful themes and structures describing the breadth of body marking behaviors. We used Trello [45] an online project management tool, for collaboratively creating and editing lists of cards (equivalent to our groups and quotes). Once all the quotes were grouped, an in-person meeting was held to conclude the analysis and to summarize the results. XMind [46] was then used to visualize the structure of and relations between the resulting groups. Percentages are generated from the full dataset and refer to how many participants mentioned an activity, theme or body part.

Results

We organized the identified groups into three main categories: *content & location*, *reasons for choosing the body*, and *purpose of marking*.

1) Content & Location

Most participants reported marking their hands (49%) and arms (30%). Many also specified that they would mark their left hand or arm (18%), presumably because they are right handed. The legs were marked by about 12% of the participants, slightly more frequently than fingers (8%), feet, palms and wrists (all 7%). Other mentioned places include ankles and thighs

(6%), face (4%) knees (3%) and stomach (3%). Many other body parts were only mentioned once. Percentages sum up to more than 100%, because people usually mentioned more than one location for marking.

Participants stated that the location of their markings depended on the purpose of the marking, for example “*hand for notes [otherwise] around bellybutton, on arms, leg/ankle region, feet*” or “*Typically on the back of my hand for best visibility*”. Content of the markings were typically both quick facts as reminders, notes or to-do lists (64%) as well as ornamental markings which included concrete motives (28%), abstract and geometric shapes (36%), extension of the body’s natural shapes (7%) and occasionally song lyrics.

2) Reasons for Choosing the Body

People decide to create marks on their bodies either because it is *intrinsic* (21%) to what they intend to do (e.g., marking on a friend’s body to demonstrate affection), because they had *no other option at hand* (22%) (e.g., paper or a mobile device), or because the body was the *best option* given the context (19%). Markings for which the body is the *best option* or which are done because users have *no other option at hand* have in common that one could reasonably use a different medium instead.

Participants considered the body the *best option* for marking for two main reasons: *visibility* and *ease of access*. Constant visibility reinforced the information recorded on the body. As explained by one participant: “*I see my hands a lot, and if they have something written on them, I notice, and I remember*”. However, sometimes the public visibility of the markings was also

seen as something undesirable, even becoming a reason for not marking the body at all. Others, while less concerned about visibility, wanted to encode the markings so as to making them unintelligible to others: “*I try to make them obvious to me, but not to someone else who might glance over at them.*”

Ease of access, both for marking and for retrieval, allows the body to be a useful marking surface in contexts where the user is rapidly changing locations or when the user is engaged in another activity. For instance, one participant explained: “*[I mark my body] when I need a reference to go to the library and I don’t want to get some papers out, to go and find the book quickly so I don’t have to stay*”. Another participant said: “*speaking on the phone I mark my arms, or place memory notes on my hands*”. Often (14%) people stated that they chose their body if things were especially important or if there was “a sense of urgency”.

3) Purpose of Marking

We observed that markings occurred both for *Pragmatic* reasons (64%) or had motivations which were to some extent *Hedonic* (48%). A pragmatic reason participants described using their bodies for, is as always available worksheet for taking notes, quickly jotting down messages or writing a reminder. While many participants listed more than one pragmatic reason, all participants that marked their body for pragmatic reasons marked their body to remember things (Figure 4): “*when I have to remember things I write them on my hand*. Another common pragmatic motivation was identification: “*I marked my name and my husband’s phone number during an airplane trip because I was sometimes fainting and I wanted to make sure he*



Figure 4 – Reminders marked on the hand. They were described as follows: “*olio noci’*, walnuts oil expensive must move from senny shelf and store in dark, refrigerator otherwise it gets rancid. affitto: tonight must pay rent. very trivial yet essential”. The theme of creating reminders for things that were both easy to forget but especially important was also recurring in our questionnaire results.

would be called if needed”. Markings for identification purposes were also mentioned by participants who compete in sports competitions. A further pragmatic use of body markings was cheating at exams.

We grouped *Hedonic* markings into *private markings* (19%) and *markings for communication* (40%). Private markings often had the purpose of self-expression (e.g., “... *writing on the skin, is a space, a canvas, a sheet, a place, to keep alive my game of writing*”). These markings were both done in informal ways—as doodles, sketches or writings—as well as for art projects. Besides self-expression, we observed that self-affirmation was also an important private purpose. A participant, for example, stated “*very occasionally I will write the names of girls I envy in order to be reminded of my inferiority to them. The idea is that I’ll get motivation to continue losing weight. I’ve written the names of boys I like too. For motivation*”. Similar comments related to personal insecurities or overcoming an unwanted state of mind—as an alternative to self-mutilation, as an outlet for OCD, or as a reminder for self-improvement. Markings were also used in dealing with the loss of friends and loved ones, or with the idea of one’s own death: “*The fear of dying and to what would happen to us after this event makes me mark my body] ‘To acknowledge the body’, just like when you go to identify a corpse*”.

Markings that facilitate communication include parents painting their children or friends drawing on each other’s bodies. Usual motivations for this are fun and playing games (e.g., drawing little people on one’s fingers for a puppet show), or as expression of intimacy: “*I have had friends come up and draw on me. It’s a way of communication and showing affection.*”

Marking on the body was also used as an expression of affection and sexuality. This includes markings acquired during BDSM practice or as sexual foreplay: “*I suppose it has something to do with the desire to own or mark for a moment the body of the object of desire*”.

Other Observations

We observed that *cultural norms* influenced marking behavior: “*Since being in Europe no one has written on me :(but in Brazil it was much more common for a friend who had a pen to just start writing on me.*” Some participants stated that the reason for not marking themselves is that it looks ‘unprofessional’. In contrast, a participant stated that she grew up in India where henna markings were common.

The purpose of a marking was also not always established while marking. For example, a participant described that the way pens are attached to her work-uniform leads to *coincidental* markings when working. These markings were unintentional, but allowed “*coworkers and [her] to see who works the ‘hardest’*”. A similar example of was described by people who frequently go to clubs or concerts: “*they mark u and on a monday morning you can see where you’ve been before washing it away*”.

Discussion

Looking at *Location & Content* we note that, when marking for pragmatic reasons, people predominantly marked their hands and arms. However, hedonic markings were spread out all over the body. The content of the markings also varied according to location and adopted its shape to the anatomical idiosyncrasies in its surroundings.

Regarding *reasons for choosing the body* hedonic markings were typically intrinsic to the body, while pragmatic markings could also occur on paper or devices. In situations when the body becomes the *best option* for pragmatic markings, we can identify features of the body, such as the ease of access and visibility, worth preserving and expanding upon. Interactions which require focus, or deep menu navigation would not do justice to the experience of immediacy which people have in interacting with their body. A system which attempts to build on this sense of immediacy is the pose-aware display by Burstyn et al. [2].

There were many *purposes for marking*. Looking at the *pragmatic markings*, they are all self-contained. This is in contrast to many systems which use the body as an input surface for applications which occur elsewhere. Many current investigations also focus on transferring interactions from devices on the body, leading to suggestion for 'on-body gestures' which include actions such as 'delete' or '[42]. Instead of mapping actions from devices to the body, we suggest on-body interaction should be used to enhance behaviors we already engage with. A simple example of such a process are Safetytats [47] which improve the activity of marking a phone number on one's child. Another potential application might engage with the deterioration of markings. A system similar to Patina [22] might be created to commemorate the multiple stamps a club-goer receives over the course of months and years.

While the HCI community has mainly explored pragmatic interactions, our data suggests hedonic markings were almost as common. Topics such as communication and intimacy were prominent, yet as a

community we only have a poor understanding of interactions in which people touch each other. What kind of systems can we create to add interactivity to these social touch interactions? Future work could expand on the limited investigations which involve touch between people [4,14,35].

An activity which came up repeatedly in responses to our questionnaire, was people encoding the writing on their body so only they can interpret it, or people not marking their body because they do not want others to see the markings at all. How can on-body systems be designed to address people's concerns about both privacy and visibility? This points to a more general tension between the very personal nature of the skin and the perception of the skin as a public display. Resolving this tension of the most private of imaginable interfaces also being a public display is a challenge in the design of future on-body systems.

Conclusion

While we recognize the potential of approaches that transfer methods and applications from devices to the skin, we hope to have demonstrated that on-body systems need not be limited to that. We believe that on-body interactions deserve to be considered for their own merit, not just as an extension of existing devices. Doing so may open up the door for unique interaction methods and applications beyond what the HCI community have considered so far, and that are worth to be studied.

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