




I've Gut Something to Tell You: A Speculative Biofeedback Wearable Art Installation on the Gut-Brain Connection

Line Krogh Sommer, Johanna Møberg Lauritzen, Alberte Spork, Louise Biller, Mathilde Merete Jensen, and Brian Bemman^(✉) 

Aalborg University, Rendsburggade 14, 9000 Aalborg, Denmark
bb@create.aau.dk

Abstract. The gut-brain connection is an increasing area of focus in many research domains. In the field of human-computer interaction (HCI), numerous biofeedback technologies provide detailed information on various bodily functions, however, those designed for the bowels are limited. Additionally, arts-based research methods are increasingly being utilized in HCI for investigating lived experiences with technology. In this paper, we present an interactive art installation and wearable artifact called *I've Gut Something to Tell You*, which provides a speculative way of somatically connecting with one's bowels through technology, namely, through 'translations' of bowel sounds into written language derived from the researchers' own investigations into experiences with their bowels. Participants' experiences with the installation were evaluated through a thematic analysis of written narratives and interviews while poetic inquiry was used to communicate the prominent themes that emerged. Our findings highlight a recognition of the importance of the gut-brain connection but suggest further that one's subjective experience of this connection remains complicated due to societal taboos surrounding the topic. More broadly, our work challenges the notion of what constitutes biofeedback and our findings provide interesting reflections from the perspective of soma design regarding how we view our bowels as a separate but vocal entity which cannot be controlled in contrast to some other organs.

Keywords: Interactive Art · Wearable · Biofeedback · Soma Design · Speculative Design · Narrative Inquiry · Poetic Inquiry · Gut-Brain Connection

1 Introduction

A person's relationship to their body and, in particular, their bowels can be complex for many reasons, not least of which concerns norms in much of the Western world aimed at often suppressing bodily functions in public discourse and experience. However, research efforts in studying the nature of the connection between the gut, brain, and mental states are steadily increasing with

wide-ranging and notable contributions from the medical community, medical humanities researchers, and artists alike [10]. Additionally, related contributions from the field of human-computer interaction (HCI), have resulted in countless biofeedback devices and technologies (e.g., smart watches) that provide users across a variety of contexts (e.g., games and sports) with intimate information and near continual awareness of various bodily functions from heart rate variability [33], blood pressure [17], and respiratory response [32] to neurological [18], thermal [22], and galvanic responses [8]. However, comparatively fewer devices and technologies relate to the gut [19,35] while what such biofeedback would mean for controlling the functioning of one's bowels and a general understanding of the long-term effects that such information and use of technologies have on the relationship between one's mind/psyche and body remain unclear. Fortunately, there are increasing calls in HCI for the need to consider the body not merely as an object for interaction with technology but as lived experience [24,31], which may help alleviate this concern. Artistic research methods, such as speculative design [9] and soma design [13], offer compelling ways in which to answer this call while at the same time challenging the ways in which we relate to the inner workings of our bodies. Other related methods, such as poetic inquiry [7], can possibly provide further means for better communicating the emotional meaning of any insights that may emerge.

1.1 Contribution

This paper presents an interactive art experience and wearable artifact called *I've Gut Something to Tell You* intended as a speculative- and soma-design inspired installation that provides an alternative way of connecting with one's bowels through technology. Specifically, the intensity of a person's bowel sounds are artistically interpreted as written words and phrases derived from the researchers' investigations into their own relationships with their bowels. The primary aim of this research is to investigate the use of art and artistic methods of inquiry for probing the feelings and reflections we have about our bodies through a speculative device that quite literally gives 'voice' to one's voiceless bowels and further challenges the notion of what constitutes biofeedback among devices that ordinarily monitor and inform users of their bodily functions. In Sect. 2, we provide an introduction to arts-based research and the methods of narrative and poetic inquiry as well as overviews of speculative- and soma- design. In Sect. 3 we present the design and implementation details of *I've Gut Something to Tell You*, which utilized soma-design practices and narrative inquiry. In Sect. 4, we introduce the experiment we carried out with participants who experienced the installation/wearable and present the themes that emerged from a thematic analysis of their narratives and interviews as well as a collection of poems the researchers made with respect to these themes using poetic inquiry. In Sect. 5, we conclude with a brief summary of our findings and directions for possible future work.

2 Related Work

Artistic practice has been argued to be a useful part of research insofar as artists can ask important questions while also responding to the unexpected in ways that traditional researchers are not necessarily so inclined [29]. Importantly, visual and sensory explorations in artistic practice serve in research as the “basis for compiling thematic patterns of evidence from which meaning is made vivid” [29, p. 56]. Both artists and their audiences alike can make meaning by seeing and sensing in the ways that art affords, namely, with one’s entire body, as a means for discovering new ways of interacting with and understanding the world. This understanding is facilitated by a process of qualitative data collection and analysis which typically centers on “creating rich literary word portraits. . . that reflect the insight of the [artist or other] insider and the critical focus of the dispassionate observer” [29, p. 56].

2.1 Narrative and Poetic Inquiry

Narrative inquiry is a qualitative data analysis methodology for collecting, interpreting, and organizing spoken and written data in the form of personal anecdotes or narratives [7]. Narratives are particularly useful in documenting personal experiences because they are “a distinctive way of thinking and understanding that is unique and embodied, that is, . . . [they] integrate. . . the physical and psychological dimensions of knowing” [7, p. 73]. It is perhaps not surprising then that narrative inquiry has been employed in various humanities disciplines and appears particularly well suited to investigating necessarily embodied activities, such as artistic expression and experience.

A related mode of inquiry and arts-based research methodology known as poetic inquiry has been described as a particularly artful way of doing research [7] which, like narrative inquiry, has been employed in different social science disciplines, such as psychology and education [23], as a means for collecting, interpreting, and organizing qualitative data. Central to this approach is the creation of poetry as inquiry and the recognition that poetry itself can be an effective means for expressing and learning within research. The goals of poetic inquiry may vary from improving researcher reflexivity [12] and preserving an individual’s voice [34] to providing more emotionally impactful, engaging, and accessible research [11, 21]. One type of outcome with poetic inquiry is found poetry, which is the “rearrangement of words, phrases, and sometimes whole passages that are taken from other sources and reframed as poetry” [7, p. 97]. Found poems can be created by changing the phrasing and order of words in a set of data, resulting in a so-called treated poem, or by allowing the data’s original phrasing to remain mostly intact, resulting in an untreated poem. Poetry clusters are collections of such found poems that center on a singular theme often corresponding to a participant’s experience and object of study, that investigates the data on a deeper level than only one poem could manage.

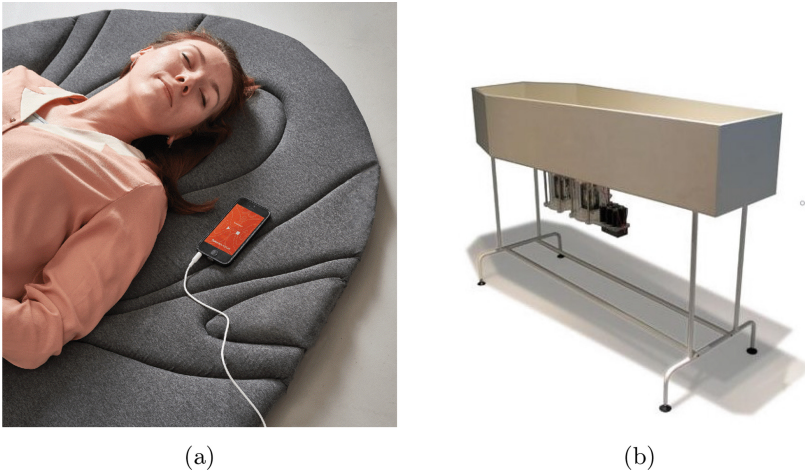


Fig. 1. The Soma Mat [27] in (a) and Afterlife (2009) [4] in (b).

2.2 Soma Design

Soma design is a methodology for helping to ensure that designers create artifacts that better support the sensations, emotions, and subjective experiences of their users while encouraging deeper aesthetic appreciation for living a better life [13]. One's goal with soma design might be the relatively basic pleasure and appreciation of exploring one's soma, or the more complex task of unlearning damaging habits, such as bad posture [13]. When designing with and for the soma, designers place considerable emphasis on their own first-person lived experience by actually engaging with their own somas, for instance, through various somaesthetic practices [25] or working thoroughly with materials before or during the actual design process [3]. It is argued that such an approach, which prioritizes care and understanding for one's own soma, improves one's ability to tend to and empathize with the somas of others. One key component of effective soma design is slow-storming, which – in contrast to the frequently fast-paced formation of ideas typically encountered in industrial brainstorming design sessions – requires that designers intentionally slow themselves in order to better articulate bodily experiences, be more thoughtful and reflective, and possibly produce more sustainable outcomes [3]. Not unlike traditional cyclic design processes, however, soma designers also iteratively test their design but with the goal of better engaging with and immersing themselves in their experience [13]. Figure 1(a) shows an example of a commercially developed product, Soma Mat [27], that was made in collaboration with IKEA and Boris Design using soma design [13, 15]. The aim of the Soma Mat is to support a person's somaesthetic abilities [25] by directing their attention to different parts of the body through heat, e.g., under a heel or hip, along with audible instructions (taken from a form of meditation known as a Feldenkrais lesson) to focus on the same body part.

Over the course of its design, the creators of the Soma Mat engaged in various bodily practices at least once a week – describing their feelings before and after each exercise to better understand each other's progress – and participated in somaesthetic workshops and Feldenkrais training. The Soma Mat was evaluated by its principal designer through an inquiry into her first-person lived experience using narratives written about her own experience using it.

2.3 Speculative Design

Speculative design is a design practice which arguably stands in stark contrast to design thinking [9]. In its more frequent usage, design is concerned with solving problems. However, in the face of particularly complex problems and world-wide crises, it has been argued that simply designing our way out of these may not always be sufficient, as this may lead to a false understanding of their severity and shift focus away from the importance of ideas and attitudes that can potentially have just as much impact towards being able to solve them than the problem-solving designs themselves [9]. Speculative design is thus more concerned with asking questions – it provokes, offers alternative viewpoints and ways of being to the status quo, and encourages imagination, reflection, and critical thinking, particularly with respect to technological advancements and serious global concerns [9,30].

The value of speculative design lies in how it makes people feel, and there are several instructive criteria to consider. Often times, speculative designs work with improbable scenarios that could emerge within the bounds of science but are not likely to, and straddling this border between the real and fictional is what makes speculative design impactful. Such scenarios are frequently placed within the realm of some possible future or alternative present as tangible and often humorous or absurd objects of study intended to spark thoughts of not necessarily how things should be but how things could be – leaving it up to the viewer to decide if such visions are preferable or not. Figure 1(b) shows one such speculative artwork called *Afterlife* (2009) [4] that envisions a fictional future technological device in which the chemical potential of a corpse is converted into electrical energy and contained within a battery. Viewers of the artwork were asked to consider how they might use an afterlife battery charged either by themselves or a loved one and in so doing were provided with an alternative and humorous way of thinking about death that made an ordinarily difficult subject to discuss more accessible.

3 Design and Implementation of I've Gut Something to Tell You

In this section, we provide an overview of the design process and implementation details for the two primary components of *I've Gut Something to Tell You*: (1) a wearable artifact and (2) an interpretation screen for visualizing bowel sounds and their intensities through text – both of which were developed using practices inspired by speculative- and soma-design under the guiding premise and speculative problem of “Listening to what my bowels are saying”.

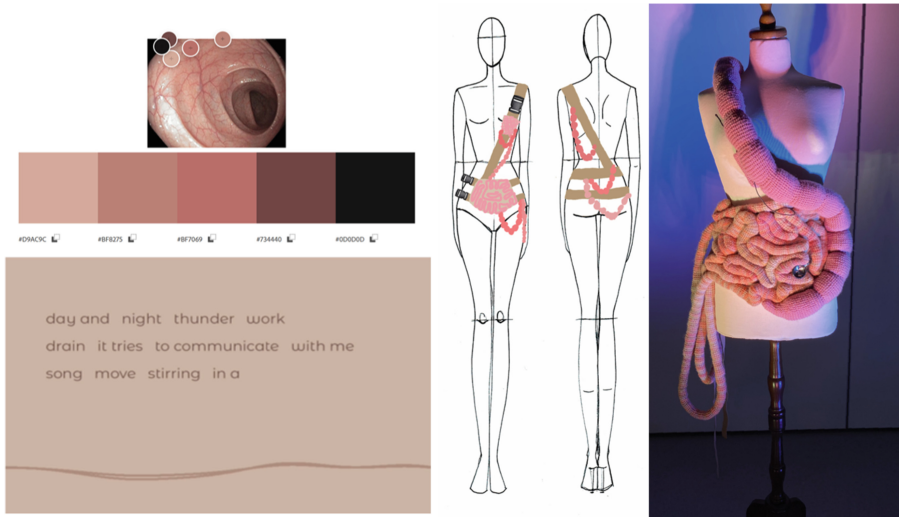


Fig. 2. Design details of *I've Gut Something to Tell You* with chosen color palette (top left), visualization screen of bowel sounds through textual interpretation and intensity (bottom left), early conceptual sketch of the wearable bowels on a figurine (middle), and final implemented version of the wearable bowels (right).

3.1 Design Overview

Figure 2 shows the various design details of the wearable artifact and visualization screen that make up *I've Gut Something to Tell You*. One will first note that the color palette (top left) used in both the visualization screen (bottom left) and the wearable itself (middle, right) consists of colors inspired by those present in the human digestive tract. The wearable artifact consists of approximately anatomically correct dimensions of the human intestines (small and large) that have been crocheted using patterns taken from [28] having a visual and textual appeal that invokes empathy and comfort (rather than disgust), as emphasized in soma design. The intestines lie fixed to a harness worn about the waist such that they resemble their actual internal placement of the wearer while a shoulder strap keeps the electronic components in place which are further obscured by a portion of the large intestine. Iterative prototyping and simple majority decision voting were used to improve upon the materials used, the fit and form of the underlying harness, and the overall visual aesthetic of the wearable and interpretation screen.

Interpreting Bowel Sounds as Words and Phrases. As a central component of *I've Gut Something to Tell You*, the process of gathering the reflections and feelings which arise when experiencing bowel sounds, the way in which these sounds are interpreted into words, as well as how their interpretation is presented to the wearer, has a significant impact on the overall experience. The process of

interpreting bowel sounds into words followed four main steps carried out by the researchers: (1) a logging period in which all the researchers used a stethoscope to listen to the sounds of their bowels over the course of a day and recorded various information of notable events (2) first-person narrative writing about the experience of listening to their bowels inspired by narrative inquiry, (3) a collective discussion of the researchers' reflections and feelings concerning their experience, and (4) a collective slow storming session borrowed from soma design for aligning the words and phrases taken from the logging period, narratives, and discussions on the researchers' respective experiences.

The logging period allowed for an understanding of the first-person lived experience of the researchers' relationship with their bowels, as emphasized in soma design. The information collected concerned basic physiological reports regarding e.g., what times during the day any sounds were most prominent, how these sounds changed due to bodily processes, such as eating, drinking, and bowel movements, as well as how they responded to different body positions e.g., sitting, standing, and lying down, which helped to inform the set up of the evaluation (discussed in Sect. 4). Additional information was collected, such as which of the four abdominal quadrants (upper and lower-right and left) resulted in the most sound as well as a description of what the noises sounded like and specific words and phrases that came to mind while listening, which served to inform the construction of the wearable and design of the interpretation of bowel sounds, respectively. Many of the words that emerged during the logging period were associated with water or animals, some examples being 'diving', 'bubbles' and 'a roaring frog'. In communicating our experiences to one another, different perspectives emerged. For example, one researcher imagined how bowel sounds could be thought of as notifications that alert us to various bodily needs. Several researchers experienced listening to the sounds of their bowels as a meditative practice involving getting lost in the sounds and losing awareness of thoughts. Listening to our bowel sounds was often amusing as well and inspired different visualizations of the bowels – for example, thinking of them as an animal or an alien, as a home to several beings, or as a friend in need of compassion.

The information collected from the logging period, narratives, and collective discussions served as the text from which we drew on during our slow storming phase. During this phase, we selected words and phrases that most aligned with our experiences over the course of several weeks of relating to our bowels (e.g., through meditation and bodily awareness sessions) during the design process and internal testing of the wearable. Towards the middle of this phase, we categorized the words and phrases that had so far emerged through a thematic analysis and then in the remaining time of this phase added additional words or phrases within these themes. The final set of words and phrases that emerged within these themes as part of this process became the text that would be selected from and displayed on the interpretation screen and represented a variety of experiences,

reflections, and feelings from the researchers e.g., animals, movement, music, feelings, the weather and traveling, as well as questions and song lyrics.

3.2 Implementation Overview

Figure 3 shows an overview of the implementation details of *I've Got Something to Tell You* which consist of its two main components of the wearable and the interpretation screen (top) and how the electronic and technical features were connected (bottom). A stethoscope is placed within the lower left quadrant of the small intestines of the wearable and the sounds detected with it are passed to a simple wireless audio transmitter which sends these sounds to a sound mixing board and later to the computer. The software, Processing [1], is used to interpret the intensities of bowel sounds into text that appears on a visualization window which is then projected using a projector. Two speakers connected to the sound mixing board allow participants to hear the sounds of their bowels directly from the stethoscope while the projected interpretations allow participants to read the text and imagine any voice of their bowels themselves. In order to further reinforce the sometimes imperceptible physical feeling of bowel activity, the amplification of bowel sounds were visually represented at the bottom of the visualization as a waveform whose amplitude fluctuated in accordance with the intensity of the sounds detected by the stethoscope.

Visualizing Interpreted Bowel Sounds as Words and Phrases. In implementing the text-based interpretation of bowel sounds, we decided on an approach in which words and phrases are selected and presented in a (mostly) nonsensical and non-grammatically correct “stream-of-consciousness” way, which we believed encouraged imagination in line with speculative design while remaining relatable insofar as they reflect the thoughts and feelings of the researchers’ own experiences with their bowels. The textual interpretation of bowel sounds are thus mapped according to three conditions: (1) low intensity bowel sounds result in a randomly chosen word or phrase (e.g., ‘day and night’), (2) high intensity bowel sounds result in a randomly chosen exclamatory word or phrase (e.g., ‘fantastic!’), and (3) five seconds of bowel sound inactivity results in a randomly chosen pause word (e.g., ‘umm’, ‘hmm’ or ‘like’). As shown in Fig. 2, the randomly chosen words or phrases from any given condition are displayed on the visualization screen in sets of four available slots one row at a time, beginning from the bottom row and ‘scrolling’ upwards to the next row in type-writer fashion following each new condition and disappearing after three rows.

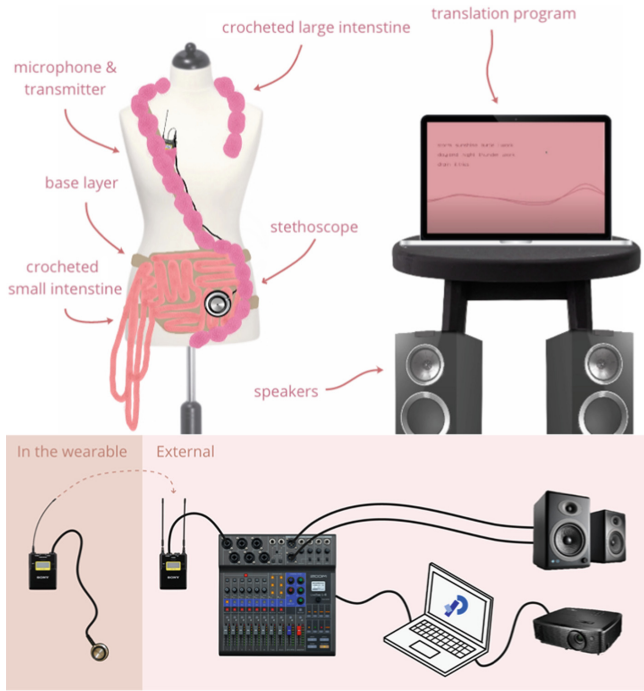


Fig. 3. Overview of the implementation details of *I've Gut Something to Tell You*.

4 Evaluation

In this section, we detail our evaluation process carried out with participants who experienced *I've Gut Something to Tell You* both with and without textual interpretation of their bowel sounds and were asked to detail their experience in the form of written narratives and interviews. We conclude with an analysis of our participants' experiences that consists of the common themes that emerged through thematic analysis of their responses and poems created by the researchers for these themes using poetic inquiry.



Fig. 4. Evaluation space of *I've Gut Something to Tell You* with one individual lying down while wearing the artifact and looking up at a projection of the visualization screen showing the textual interpretation and intensity of her bowel sounds.

4.1 Participants

We collected data from five, volunteer participants (4 female and 1 male) with an average age of 24.2 ± 1.7 years. All participants reported having similar levels of education and socio-economic standing, as well as having the same ethnicity and culture background. Of these participants, one reported current or prior formal training in the health care sector while another reported prior formal experience with interactive art. All other participants reported either a basic level or no prior experience with either interactive art or health. All participants were informed of what would occur during their experience with the installation as well as how their data would be used. Consent was obtained in accordance with the participating university's ethical guidelines for conducting non-medical experiments with human participants.

4.2 Procedure

We began by inviting each of our five participants to experience *I've Gut Something to Tell You* alone in a relatively quiet, dimly lit, and comfortable room, free of external stimuli which could detract from the experience of getting in touch with their bowels. After obtaining consent, participants were introduced to the wearable and informed of what would happen over the course of the session and approximately how long it would last. Afterwards they were offered something to drink as a means for encouraging any bowel activity and subsequent sounds. Participants were then assisted with putting on the wearable and then asked to lie face-up (with eyes open) on a thin mattress placed in the center of the

room. As shown in Fig. 4, approximately two meters above each participant was a piece of light-colored fabric onto which the visualization screen was projected from behind by a projector fixed to the ceiling of the room. For each participant, the visualization screen first displayed the interpreted text and waveform intensity of their bowel sounds for five minutes, after which the text vanished and they saw only the waveform intensity for an additional five minutes. The text appearing in the first condition served as a visual cue for priming the participant to attend more closely to the sounds of their bowels (similar to the heat spots in the Soma Mat [27]) while the following period without text allowed them to more freely and directly connect with their bowels in a somatic manner more akin to their ordinary daily experience. Two speakers placed in opposite corners of the room provided the amplified sounds of each participant's bowels during both conditions of the session. Following this 10-minute period, one researcher entered the room and asked the participant to provide a written narrative (in any form) on a laptop concerning their initial thoughts and feelings about what they experienced. Additionally, they were provided with the text of their bowel-sound interpretations as a memory recall aid. Participants were given an additional 10 minutes alone to complete their narratives after which two researchers returned to the room to carry out a final semi-structured interview. The total experience for each participant lasted anywhere from 45 to 60 min depending on how long the interview lasted.

Interview Questions. The semi-structured interview consisted of 11 main questions with 6 follow-up sub-questions to several of the main questions. Questions such as “Do you think about your gut in your daily life?” and “How would you normally interpret your bowel sounds?” were aimed at understanding the participants' existing somatic relationship with their bowels. Other questions such as “How did it feel to have the wearable on?”, “Did the experience make you particularly aware of something inside yourself?”, “What was it like to listen to the bowel sounds with the written interpretation?”, and “What did the words mean to you?” were intended to understand the participants' experiences with the installation and how it may have promoted a somatic connection with their bowels. The question, “Do you feel that the experience gave you either a new or different understanding, or greater awareness of your bowels?” was aimed at determining whether their experience provided novel insight into their relationship with their bowels or possibly expanded their somatic awareness and understanding. The question, “If you had a way to always talk to your intestines or for your intestines to talk to you, e.g., via an app, how do you think that would affect your daily life?” was meant as a speculative question designed to provoke (1) imaginative reflections from participants regarding what such a relationship with their bowels, if possible in the future, would mean for them and the somatic relationship to their bowels, and (2) critical assessments of biofeedback devices that already provide continual monitoring of our bodies.

Table 1. The four themes and final set of codes for each that emerged from a bottom-up thematic analysis of participants' narratives and interview responses after having experienced *I've Got Something to Tell You*.

	Theme	Codes
1	Speculating on the pros and cons of listening to one's body	Hyper-awareness of own body, medical/anatomical reflections, overthinking, contradictions, knowing if something is good or bad for you
2	Thinking of the gut as an independent actor	Memories, personification of bowels, overthinking, contradictions, knowing if something is good or bad for you
3	Pondering how the body and mind are connected	Positive feelings, medical/anatomical reflections, whole body and mind is connected, feeling understood, personification of bowels
4	Reflecting on the taboos surrounding one's bowels	Taboos, negative feelings, overthinking regarding what others think, medical/anatomical reflections, hyper-awareness of bodily sounds

4.3 Analysis Methods

In our analysis of the responses provided by participants in their narratives and transcribed interviews, we used a bottom-up approach to thematic analysis [5] wherein five of the researchers were assigned to five distinct coder pairs such that each researcher would code the responses from two different participants and all participant responses would be coded. Each researcher in a pair independently read one of the participant's responses and then generated a set of codes which were then checked against those found by their respective coding partner in a coder-pair consensus period. These five sets of codes were then further narrowed down to a final, single set of codes following a consensus period with all five researchers. Following this consensus period, the researchers worked together to identify a set of themes that best encapsulated the experiences of participants by grouping the final set of codes into distinct subgroups or themes on the basis of their similarity. These themes were then collectively reviewed and named accordingly. Finally, the method of poetic inquiry known as found poetry was used to create a poetry cluster [7] consisting of a single treated found poem from one researcher for each of the themes identified by our thematic analysis described above and using the coded responses from all participants in the given theme.

4.4 Results

There were four significant themes shown in Table 1 (and discussed below) that emerged from the participants' experiences with *I've Got Something to Tell You*.

Speculating on the Pros and Cons of Listening to One's Body. It was apparent in most of the participants' responses that the experience created a hyper-awareness of their own body that was at times strange, confusing, or

uncomfortable, with participants stating that “I became very aware of the feeling in my stomach and it was a little uncomfortable”, “I became very aware of how it feels inside my stomach and how I was feeling and what they [the bowels] were saying”, and “I don’t think I have ever been faced with how uncomfortable it [bowel sounds] actually makes me feel”. However, other responses nonetheless indicate that the experience provoked positive feelings and reflections of amazement, amusement, or contentment, with one participant stating that “the sound became kind of oddly relaxing to me” and another expressing that “I started giggling at one point” and that “It was very fun, very eye opening. Way more intense than I had anticipated”. Moreover, for many of the participants, whether the experience was negative or positive, it encouraged reflections with respect to their own health, with one participant remarking, “I also thought about if it’s a good or bad thing that it makes a lot of noise or not, and how important it actually is that you think about it.” This same participant reflected in the following way on whether it would be useful to have such a device that provided feedback about one’s bowels: “I think that it could be a good idea, then it could say if it’s unwell or if you should eat something or drink something or, do something differently. So, I think that it could be pretty nice, very healthy... as long as one doesn’t become obsessed with it.” While another further cautioned that “I think there needs to be some balance. Listening to your body can get very extreme, and not listening can be very dangerous, too. So, I think there needs to be some kind of balance between knowledge and listening to your body and your own experiences”. Despite rather contradictory perspectives taken by some participants, most acknowledged the importance of listening to one’s body, with one participant remarking that “I want them [bowel sounds] to be heard, but I do not want anybody else to hear!”

Thinking of the Gut as an Independent Actor. The combination of text and amplified bowel sounds also led many of the participants to personify their bowels as something which acts in accordance with its own autonomy. One participant recalled a thought he had during the experience in the following way: “Okay, this is my bowels talking or am I talking to the machine and the bowels talk back to me or something like that? I thought some of those noises represent feelings, like ‘hmmm’ means you wonder. And I thought, what do your bowels sound like when you wonder upon something? And it got me to think maybe my bowels, they have thoughts, too, of themselves somehow.” Another participant expressed a similar sentiment, “Well, with the words that came, I was wondering what it meant, and how to interpret that. Because it [the gut] felt like it was trying to say something but couldn’t get the sentence done”. In some of the participants, certain memories were triggered that suggested the bowels as an independently acting entity. For example, one participant recalled, “It [the experience] reminded me of when I was little and had to sleep and I could hear

my parents who were outside my room. I could hear them walking around and doing different things”.

Pondering How the Body and Mind Are Connected. Many of the participants were provoked to reflect broadly on their relationship to their body as a whole. For some participants, this included medical or anatomical reflections, for example, with one stating, “The interpretation of the words that was on the screen, like, how would the mind communicate with the bowels? Cause I read the words, my mind read the words, but that’s not how it works, it’s just like. . . I don’t know, stuff in your body that does stuff like that, cells and electrodes and I don’t know. So, I guess I thought about, how do they actually communicate?”. Other reflections spoke more to the mind as being distinct from the body with this same participant stating, “I guess you experience the extremes, the highs and lows of whatever your bowels do. But all the things in between, they’re not that noticeable because you’re just going on inside your head”, while another participant acknowledged a similar distinction but reached a unified conclusion with the following: “Maybe you tend to think that your top part, that your head is the only part that’s you, but that it [the experience] became so personal it was reassuring that my whole body is me. Even the gross intestines also experience with you what happens throughout your life”.

Reflecting on the Taboos Surrounding One’s Bowels. The overall negative feelings and reflections expressed by participants during their experience possibly speak to the general taboos and negative perceptions in society surrounding our bowels and our relationship to them. For example, one participant stated, “I feel like the digestive process is kind of taboo. So, we’ve as a society been conditioned to believe that excrement. . . is disgusting. And while I don’t believe it’s a topic we should be discussing as openly as the weather, it is quite interesting how we almost blush just at the thought of mentioning something like that. Even if it’s to a medical professional. It’s a completely natural process, so we shouldn’t have to be ashamed of it”, and another acknowledged that “I know in my everyday life just if I am feeling hunger and my stomach starts to growl because of that I get so embarrassed and I will start to blush”. Notably, many of the female participants drew parallels to similar stigmas in society regarding menstruation, with one participant remarking in response to the words ‘blood’ and ‘lava’ that “I kind of associated it with the whole menstruation liberation-type situation that’s been going on in terms of making that [sic] okay to speak about your period, and how I mean the issue is kind of the same in terms of your bowel movements, but it’s not talked about at all”.



Fig. 5. A poetic cluster consisting of one treated poem created by a different researcher for each of the four themes identified in the participants' narratives and interview responses after having experienced *I've Gut Something to Tell You*.

Poetry Cluster Based on Identified Themes. Figure 5 shows a poetic cluster consisting of one treated poem created by a different researcher for each of the four themes identified in the participants' narratives and interview responses after having experienced *I've Gut Something to Tell You*. All four poems provide the reader with an internal monologue from the perspective of the narrator concerning their experience of listening to their bowels. The poem for our first theme concerns speculating on the pros and cons of doing so while simultaneously being hyper-aware and acknowledging a proper balance must be struck. The poem for our second theme captures the experience of coming to view the bowels as an autonomous entity that can perhaps think, feel, make decisions, and speak on its own, rather than as just something one has and that can be somewhat controlled. Despite varying degrees of agency and independence attributed to the narrator's bowels throughout as well as the tension that inevitably arises as a consequence, the narrator ultimately and reluctantly acknowledges a shared journey of two, independent equals. The poem for our third theme reinterprets this shared journey of independent actors through the narrator's expressions of surprise, wonder, and the ultimate realization and acceptance that the whole of their body and mind are in fact connected as one. The poem for our fourth and final theme encapsulates the narrator's experience of a general sentiment evident across all themes, namely, of the complexity that exists in the relationship one

has with their bowels by virtue of them being viewed negatively by both the individual and society.

4.5 Discussion

Recall that the overall aim of *I've Gut Something to Tell You* was to investigate the use of art and artistic methods of inquiry for probing the feelings and reflections we have about our bodies and challenge the notion of what constitutes biofeedback through a speculative device that interpreted bowel sounds as written words and phrases derived from soma design practices. While the combination of the particular methodologies used here is not novel [3], the outcomes presented here with respect to our stated aims above are worth noting. The design process for selecting words and phrases used in the installation based on the researchers' own experiences was intended to better empathize with the participants in service towards strengthening the unification of body and mind in alignment with soma design principles while the speculative component of pairing these words and phrases with the participants' bowel sounds was intended to provoke deeper feelings and reflections. It was clear for most participants, however, that the insecurity participants expressed regarding the amplified sound of their bowels overrode much of the effect that the speculative feature of words and phrases may have had. Nonetheless, this experience certainly provided an opportunity for participants to confront an uncomfortable topic or problem in line with the aims of speculative design [9,30]. The participants' negative reactions – echoed in the well-acknowledged shame within much of Western culture surrounding the topic of our bowels – raise interesting questions regarding the general nature of biofeedback. Proper bowel functioning is arguably as essential as proper heart functioning yet why should one be celebrated and another shunned? If a biofeedback device could be created to provide users with continual and detailed information concerning their bowel functioning, would they want such a device or would they equally shun it? What kind of feedback could be provided that would be informative without being embarrassing? Could or should this feedback be provided with the aim to control the bowels in the same way a smart watch can provide limited control over the heart? In the experiences of some participants, bowel functioning appeared uncontrollable as its perhaps erratic and unpredictable behavior (unlike the heart and lungs) led to its personification as an independent actor. Despite the stigma experienced by many of the participants regarding the sound of their bowels during the experience, participants largely reflected nonetheless on the importance of listening to one's body but stressed also that care should be taken to strike a proper balance in support of previous work on the long-term effects and usage of other biofeedback devices [26]. Additionally, the third theme indicated that while one participant maintained a dualist perspective with respect to their mind and body, most others attested that the words and phrases helped to better connect their bowels with their mind, possibly indicating further support for the non-dualist approach to design purported by soma design practices [14]. Moreover, being mentally invested in one's body while recognizing how it might be connected to

the mind speaks to a more holistic viewpoint which is now more widely adopted in medicine, particularly with respect to e.g., the relationship one's personality traits and emotional patterns have with treatments for irritable bowel syndrome [2,20].

Finally, the poetry cluster we presented in accordance with our four identified themes is perhaps more challenging to assess. From the perspective of poetic inquiry, however, simply using a thematic analysis to identify these themes as being important to human experience and the relationship between the mind and body in our participants arguably falls short in being able to communicate this importance in an emotionally meaningful way [11,21,23]. While we leave it up to the reader to decide how emotionally meaningful these poems are and how well they capture the underlying themes, we believe the use of actual coded responses from participants serves as an arguably more authentic way to represent our participants' lived experiences with the installation by better preserving their voice, in support of [34], while also better grounding the reader's emotional meaning derived from each poem in its respective underlying theme – much in line with the goal of poetic inquiry which seeks to “synthesize experience in a direct and affective way” [23, p. xxii]. Particularly with respect to our main area of focus in the gut-brain connection, it could be further argued that the poems align well with a “more-than-human” approach to health literacy proposed in previous work with poetic inquiry [6,16], and that they provide a more directly accessible form of communicating complex and speculative topics, particularly for those of our participants who reported no formal health training.

Limitations. There are several limiting factors which may have hindered our research. First, it is clear that the relatively small sample size means that the feelings and reflections about the experience would likely not represent those expressed in the wider population – despite the care taken by the researchers to somatically empathize with each other's own experiences during the design. Similarly, working with more culturally and ethnically diverse participants spanning a broader age range could yield more interesting insights into how artistic interpretations of bodily functions are received and related to. Second, it was evident that the sounds of participants' bowels overpowered some experiences with the written interpretations, limiting possible insights into their effect on how participants related to their bowels during their experience. Finally, it could be argued that presenting participants with the same order of bowel sounds with interpreted text followed by only bowel sounds could have biased the participants' experiences in some way, akin to an order effect of some kind. However, as each of the two scenarios were not treated as testable conditions, we do not believe this was a significant factor.

5 Conclusion and Future Work

In this paper, we presented the interactive art experience and wearable artifact, *I've Got Something to Tell You*, which artistically interpreted the sounds

of a person's bowels as written words and phrases derived from the researchers' investigations into their own relationships with their bowels. We believe our work serves as inspiration for other medical humanities researchers and artists wishing to stimulate meaningful conversations on awareness of one's body while the themes we identified help elucidate the relationship people have with the inner workings of their body through the words and phrases they use to speak about it. More broadly, we believe the combination of multiple artistic research methodologies, namely, speculative- and soma-design practices with narrative and poetic inquiry, as applied here, offer an interesting and effective means for more empathetically probing the feelings and reflections we have about our bodies, communicating these findings in a more emotionally meaningful way, and challenging the notion of what constitutes biofeedback, particularly with respect to taboo or difficult topics. In possible future work, it would be worthwhile investigating deeper phenomenological investigations into the participants' experiences as well as how to more reliably detect various bowel sounds, possibly through the use of additional stethoscopes. It would also be interesting to reconfigure the installation as a "feedback loop" in which participant responses are gradually added to the software, resulting in an ever-growing database encapsulating the collective 'voice' of all our bowels.

References

1. Processing (2023). <https://processing.org/>, Computer Software (version 4.2)
2. Agostini, A., Scaioli, E., Belluzzi, A., Campieri, M.: Attachment and mentalizing abilities in patients with inflammatory bowel disease. *Gastroenterology Research and Practice* 2019 (2019). <https://doi.org/10.1155/2019/7847123>
3. Asgeirsdottir, T., Comber, R.: Making energy matter: Soma design for ethical relations in energy systems. In: *Proceedings of the 2023 CHI Conference on Human Factors in Computing Systems*, pp. 1–14 (2023)
4. Auger, J., Loizeau, J.: *Afterlife* (2009) Artwork
5. Braun, V., Clarke, V.: Using thematic analysis in psychology. *Qual. Res. Psychol.* **3**(2), 77–101 (2006). <https://doi.org/10.1191/1478088706qp063oa>
6. Brown, M.E., Kelly, M., Finn, G.M.: Thoughts that breathe, and words that burn: poetic inquiry within health professions education. *Persp. Med. Educ.* **10**(5), 257–264 (2021)
7. Butler-Kisber, L.: *Qualitative inquiry: thematic, narrative and arts-based perspectives*. SAGE Publications Ltd (2018). <https://doi.org/10.4135/9781526417978>
8. Dillon, A., Kelly, M., Robertson, I.H., Robertson, D.A.: Smartphone applications utilizing biofeedback can aid stress reduction. *Front. Psychol.* **7**, 832 (2016)
9. Dunne, A., Raby, F.: *Speculative Everything: Design, Fiction, and Social Dreaming*. The MIT Press (2014)
10. Enders, G.: *Gut: The inside story of our body's most underrated organ*; trans. by David Shaw. Greystone Books (2018)
11. Fitzpatrick, E., Fitzpatrick, K.: *What poetry does for us in education and research. Poetry, method and education research: doing critical, decolonising and political inquiry*. Oxon: Routledge (2020)
12. Freeman, M.: "Between eye and eye stretches an interminable landscape": The challenge of philosophical hermeneutics. *Qual. Inq.* **7**(5), 646–658 (2001)

13. Höök, K.: *Designing with the body: Somaesthetic interaction design*. The MIT Press (2018)
14. Höök, K., et al.: Unpacking non-dualistic design: the soma design case. *ACM Trans. Comput.-Human Interact. (TOCHI)* **28**(6), 1–36 (2021)
15. Höök, K., Ståhl, A., Jonsson, M., Mercurio, J., Karlsson, A., Johnson, E.C.B.: Cover story somaesthetic design. *Interactions* **22**(4), 26–33 (2015)
16. Lupton, D.: ‘Things that matter’: poetic inquiry and more-than-human health literacy. *Qual. Res. Sport, Exercise Health* **13**(2), 267–282 (2021)
17. Ma, H., Bian, Y., Wang, Y., Zhou, C., Geng, W., Zhang, F., Liu, J., Yang, C.: Exploring the effect of virtual reality relaxation environment on white coat hypertension in blood pressure measurement. *J. Biomed. Inform.* **116**, 103721 (2021)
18. Marin-Pardo, O., Vourvopoulos, A., Neureither, M., Saldana, D., Jahng, E., Liew, S.-L.: Electromyography as a suitable input for virtual reality-based biofeedback in stroke rehabilitation. In: Stephanidis, C. (ed.) *HCI 2019. CCIS*, vol. 1032, pp. 274–281. Springer, Cham (2019). https://doi.org/10.1007/978-3-030-23522-2_35
19. Mladenović, J.: Considering gut biofeedback for emotion regulation. In: *Proceedings of the 2018 ACM International Joint Conference and 2018 International Symposium on Pervasive and Ubiquitous Computing and Wearable Computers*, pp. 942–945 (2018)
20. Muscatello, M.R.A., Bruno, A., Mento, C., Pandolfo, G., Zoccali, R.A.: Personality traits and emotional patterns in irritable bowel syndrome. *World J. Gastroenterol.* **22**(28), 6402 (2016)
21. Nichols, T.R., Biederman, D.J., Gringle, M.R.: Using research poetics “responsibly”: Applications for health promotion research. *Int. Q. Community Health Educ.* **35**(1), 5–20 (2014)
22. Peper, E., Schmid, A.: The use of electrodermal biofeedback for peak performance training. *Somatics* **4**(3), 16–18 (1983)
23. Prendergast, M.: The phenomenon of poetry in research.”Poem is what?” Poetic inquiry in qualitative social science. In: Prendergast, M., Leggo, C., Sameshima, P. (eds.) *Poetic inquiry: Vibrant voices in the social sciences*, p. xix. Sense Rotterdam (2009)
24. Rapp, A., Boldi, A.: Exploring the lived experience of behavior change technologies: Towards an existential model of behavior change for HCI. *ACM Transactions on Computer-Human Interaction* (2023)
25. Shusterman, R.: *Thinking through the body essays in Somaesthetics*. Cambridge University Press (2012)
26. Siepmann, C., Kowalczyk, P.: Understanding continued smartwatch usage: the role of emotional as well as health and fitness factors. *Electron. Mark.* **31**(4), 795–809 (2021)
27. Ståhl, A., Jonsson, M., Mercurio, J., Karlsson, A., Höök, K., Banka Johnson, E.C.: The Soma Mat and breathing light. In: *Proceedings of the 2016 CHI Conference Extended Abstracts on Human Factors in Computing Systems*, pp. 305–308 (2016)
28. Stendys, G.M.: *Hæklet Anatomy. Turbine* (2020)
29. Sullivan, G.: *Art practice as research: Inquiry in visual arts*. Sage Publications (2010)
30. Sustar, H., Mladenović, M.N., Givoni, M.: The landscape of envisioning and speculative design methods for sustainable mobility futures. *Sustainability* **12**(6), 2447 (2020)
31. Svanæs, D.: Interaction design for and with the lived body: Some implications of merleau-ponty’s phenomenology. *ACM Trans. Comput.-Hum. Interact.* **20**(1) (apr 2013). <https://doi.org/10.1145/2442106.2442114>

32. Tu, L., Bi, C., Hao, T., Xing, G.: Breathcoach: A smart in-home breathing training system with bio-feedback via VR game. In: Proceedings of the 2018 ACM International Joint Conference and 2018 International Symposium on Pervasive and Ubiquitous Computing and Wearable Computers, pp. 468–471 (2018)
33. Umair, M., Chalabianloo, N., Sas, C., Ersoy, C.: HRV and stress: a mixed-methods approach for comparison of wearable heart rate sensors for biofeedback. *IEEE Access* **9**, 14005–14024 (2021)
34. Vincent, A.: Is there a definition? Ruminating on poetic inquiry, strawberries and the continued growth of the field. *Art/Res. Int.: Transdiscip. J.* **3**(2), 48–76 (2018)
35. Vujic, A., Tong, S., Picard, R., Maes, P.: Going with our guts: potentials of wearable electrogastrography (EGG) for affect detection. In: Proceedings of the 2020 International Conference on Multimodal Interaction, pp. 260–268 (2020)