Prototyping Playful Touch with a Sound-Mediating Table

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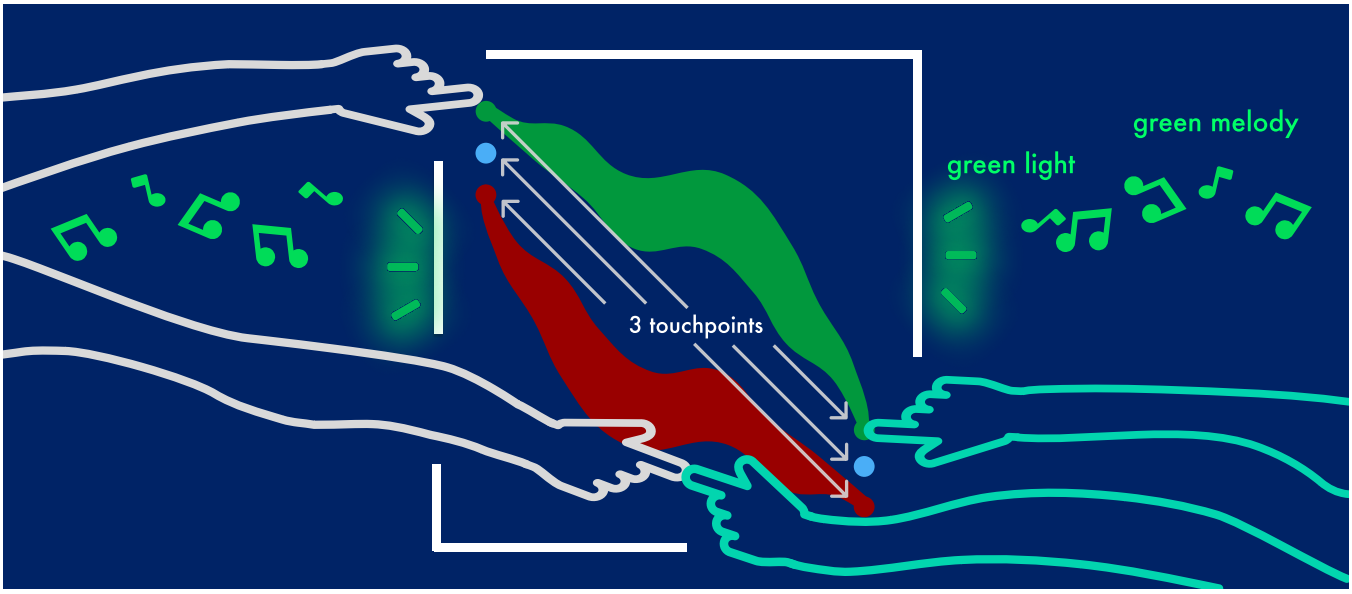

Figure 1: A top view schematic of two people playing with the table. Sound and light effects are modulated on bare-skin touch.

ABSTRACT

Playfulness and ambiguity are design intentions with a growing interest in Human-Computer Interaction. This demo describes an interactive table prototype using bare-skin touch between two users to control a soundscape supported by light. It builds on previous work in playful interactions and delivers an ambiguous connection between the modes of interaction and actuation. The prototype invites users to collaboratively interpret and experiment in order to make meaning of their touch, exploring each other's skin. We conducted a preliminary study with 13 couples and report on their impressions. This abstract outlines the design process of the interactive musical table prototype, highlighting its potential to inspire creativity and spark curiosity in a design audience.

CCS CONCEPTS

• **Human-centered computing** → **Interaction design**.

KEYWORDS

Playfulness, Ambiguity, Ludic Design, Bare-skin Touch, Soundscape, Interactive Table

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1 INTRODUCTION

While clarity in design is typically favoured in service of usability and functionality, ambiguity can be valued for its quality to allow for open interpretation. The purposeful design of ambiguous responses to user engagements with an interactive system can spark curiosity, creativity, and encourage meaning making [6]. Following a ludic design approach [5], we demonstrate an interactive table prototype that invites intentional uncertainty to facilitate playful engagements between surrounding people. This project is a spin-off from previous work by Hendriks & Gamboa, et al. [7], who study social play through touch mediated by interactive tables. The prototype applies Hobye and Löwgren's strong concept of "bare-skin touch" — giving strangers a playful excuse to physically touch through an interactive artifact [9]. Our table detects bare-skin touch through conductive dots on the tabletop. The table produces a variety of musical melodies as a response to combinations of touch positions on the table and between the participants' bodies. Through such ambiguous responses, we aim to provide participants with a playful experience as well as an invitation to reflect on the dimensions of touch.

2 DESIGN PROCESS

Our conceptual design was envisioned as a variant to the Undertable design [7], which we had tried first hand as part of a research study at our university. The inspiring table was composed of two brass strips at opposite ends, which when touched by participants, would activate a set of fans hidden under the table. We chose to create an alternative version of a similar table-based interaction — adding some complexity to the modalities supported. In this project, instead of airflow and light, we leverage light and sound as the actuation and response of the table to bare-skin touch. Similarly, however, we maintained an intention of balancing ambiguity in order to achieve the internal complexity 'sweet spot' described by Hobye: a balance between lack of clarity and enough response to captivate the user to stay within the interaction.

Inspired by Cao, we aimed to encourage social interactions by integrating sensory modalities into our interactive table. This included adapting soundscapes to match the context[3]. Building on Tarr et al.'s findings on synchrony and social bonding, we offered different table states to synchronise with the mood of ongoing interactions, thereby influencing them [10]. Additionally, drawing from Alvarsson et al.'s research on the stress-reducing effects of natural sounds, one table state focused on promoting relaxation to facilitate socialising, aligning with Cao's insights. Lastly, Erkut et al. claim that shifts in tempo (such as the ones we to had in our design), "are so salient that they can affect the psychological states of subjects participating in an action".

The patterns on the table and using the artifact as a couple was primarily inspired by Crdl [11], where a touch-sensitive instrument was used to mediate affective communication through sound and touch between people with dementia and family members. The colour sound combination was inspired by Hobye and Löwgren's interactive suit. Our background research on soundscapes combined with these inspirations informed our interactive table's design.

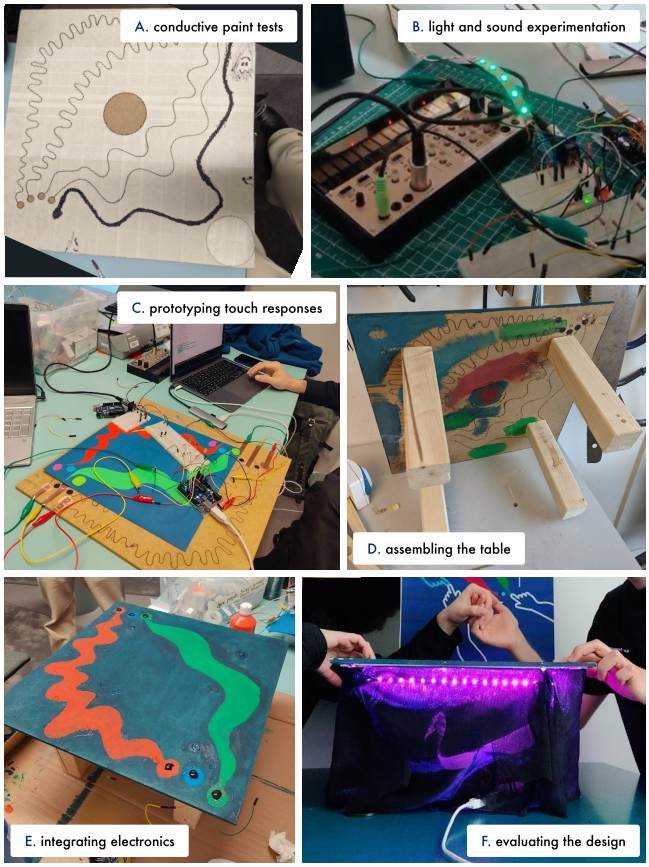

Figure 2: Different stages of prototyping: from lo-fi and light/sound experimentation to the final user testing setup

In a process to increase the complexity of the previous concept by our colleagues, we started by adding and testing features. We experimented with various design modalities, such as light and sound. We also wanted to modify the top of the table to promote experimentation and exploration, with coloured patterns inviting users to interact and discover. We decided to integrate 3 touchpoints on each side of the table, and dynamic LED lighting and sound generation beneath the table surface, synchronised with user interactions. By embracing ambiguity in sensory feedback, we aimed to evoke curiosity and promote diverse interpretations among users.

An overview of our design process is shown in Figure 2, starting from early prototyping stages, continuing with light/sound experimentation, building and painting a testable prototype in the form of a mini-size table, and finally preparing the user testing setup.

3 DESIGN

At the heart of the table are three discreet touch points (green, red, blue) positioned on opposite sides, inviting users to interact and explore. When both users touch the same point, or the same combination of points on their side, while simultaneously touching each other, they "close" the circuit and trigger auditory and visual feedback. There are 7 different states, coming from all the possible colour combinations. Beneath the surface, hidden behind a discreet

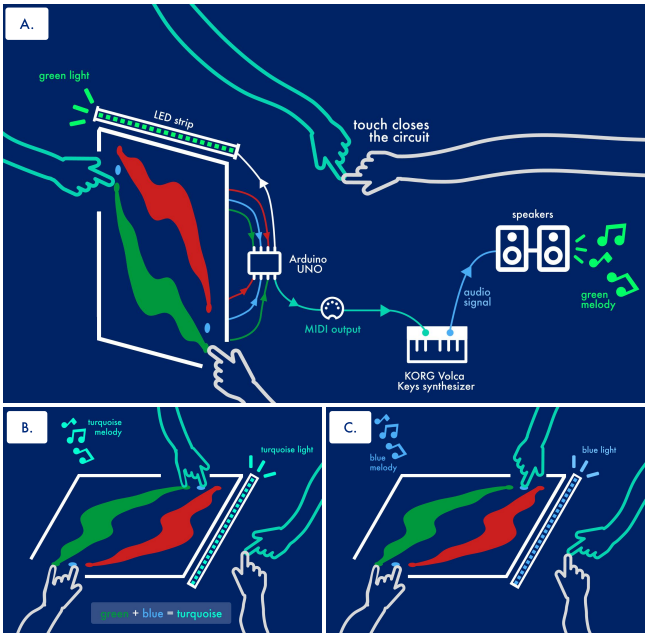

Figure 3: A: An overview of the technical composition. B and C: Both users have to touch the a combination of points, and each other at the same time to activate the intended state.

cloth, lie the Arduino microcontroller and associated electronics, including an LED strip, an analog synthesiser and speakers.

We utilised MIDI (Musical Instrument Digital Interface) alongside Arduino to enable the transmission of MIDI signals for synthesiser control. MIDI, a standardised protocol for exchanging musical data among electronic devices, facilitated communication between the Arduino microcontroller and a KORG Volca Keys analogue synthesiser. Through programming on the Arduino platform, we interpreted sensory input combinations, translating them into diverse melodies. These MIDI signals were then sent to the synthesiser, producing dynamic auditory outputs. In addition to sound feedback, the table incorporates dynamic LED lighting, also synchronised with user interactions. The integration of vibrant, colorblind-safe coloured patterns on the tabletop, coupled with the LED strip beneath, creates a visually captivating environment. Users are encouraged to experiment with different touch patterns, producing unique auditory and visual responses with each interaction, open to interpretation.

4 EVALUATION AND ANALYSIS

We deployed the table in a student environment, with a camera and microphone set-up to record by the table. See figure 4 for a representation of the study set-up. We recruited 13 pairs of students, gathering informed consent to record their interactions. Participants were allowed to interact uninterrupted for 5 minutes, after which we conducted semi-structured interviews. Examples of questions we asked were about their relationship to another, whether they could describe what happened, how it made them feel, and how they interpreted the sound and light. We took observational notes from the videos and transcribed the data from the interviews.

The time taken to understand how to use the table ranged from as quick as 5 seconds to as long as 45 seconds. The duration of usage varied, with some couples using it until they were interrupted at 5 minutes, while others used it for shorter periods. The body parts touched during the interaction included fingers, hands, and in some cases, more unique contacts like ankle to ankle or forehead to forehead. Some couples were seen moving rhythmically to the beat. Some couples explored different combinations of touch and even attempted to create a song. Others discussed patterns or purpose, and some tried to play "notes" with constant hand touch.

We analysed the data from the interviews and observations through thematic analysis Braun and Clarke however, for the sake of this demo, we will summarise the reactions to the prototype in a loose chronological order. Participants engaged in **learning and exploration**, experimenting with touch combinations to understand the table's capabilities. Their curiosity was a strong driving force to try to understand the mechanisms behind the interactions ("How does it understand we are touching, let's try again, oh my god.", "Should we like, we touch ears, you wanna try? ear to ear? (laughs) it worked!"). This was done **collaboratively**, with a conversation on how to create strategies for their touch. Through this conversation, participants started speculating on **relational dimensions** of touch (e.g.: "So I I don't have problem with this, but I have seen that if you touch other people depending on many things, it's it's tricky. So if you I would have to hold someone else's hand for example now with you —, I wanted to explore more."). This collaborative negotiation was noted as the interesting facet of the prototype. Participants noted how they could activate the table on their own, but found that "boring", as if cheating the system.

The musical qualities of the table led into enthusiastic notes on **togetherness** ("Playing music together, creating music together"). Participants tried to **interpret** the relationship between colours and the type of music played ("Blue feels a bit spooky. The others just feel like tones, white feels like classical music. Green feels Japanese, like sitting and drinking tea. Yellow feels a bit futuristic.") — not always in line with their expectations. Most participants tried

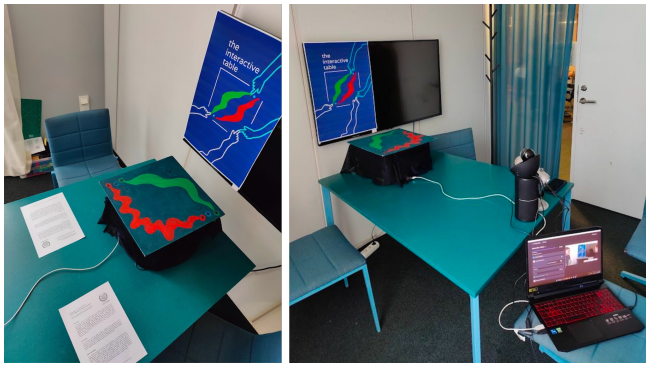

Figure 4: The evaluation set-up, representing the room with the table prototype on a conventional table, a web camera, a microphone, consent forms, a poster, and a connected laptop.

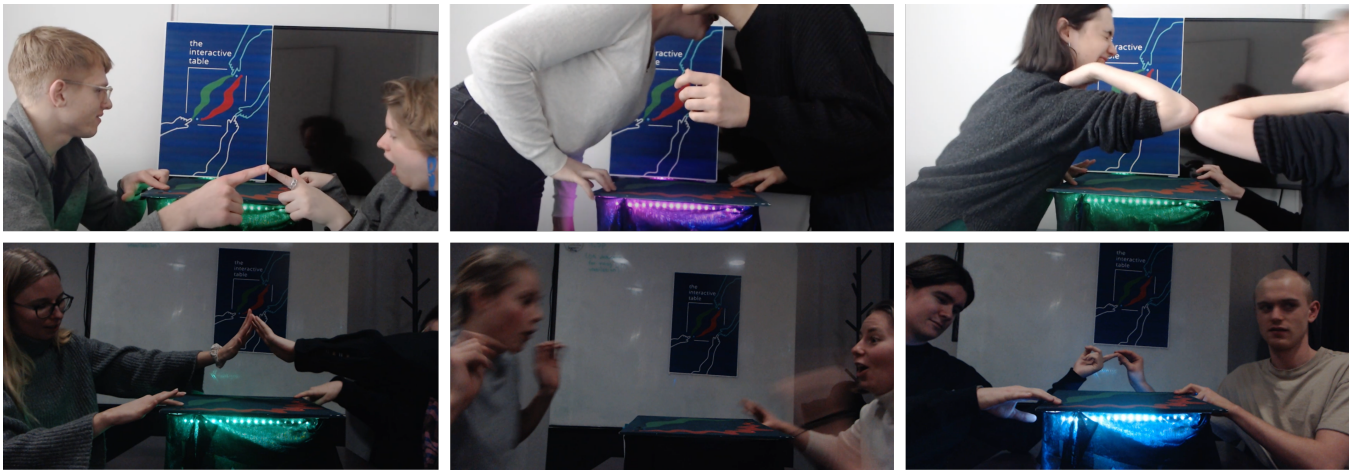

Figure 5: Some snapshots from our user study, showing playful exploration through touch and surprise.

to make sense of the **pragmatic applications** of the prototype, indicating they saw a potential for placing it in public spaces.

Participants had many possible notes for improvement. The issue of sound complexity and differentiation emerged, with some participants expressing difficulty distinguishing between the melodies generated by different colour combinations. This suggests a potential for refining the audio feedback to enhance the distinctiveness of each colour, pattern, sound and light state. Additionally, observations revealed variations in user engagement, with some couples becoming underwhelmed or bored after a relatively short time. This suggests a need for diversifying the available patterns or introducing additional elements to sustain interest over extended periods. These notes tie back to the difficult sweet spot between ambiguity and internal complexity mentioned above.

5 DISCUSSION

This exploration into tactile and sonic interactions mediated through an interactive table demonstrated facets of social dynamics and creative expression. Reflections from participants illuminate the subtlety in balancing ambiguity and clarity to allow for shared interpretative meaning making while retaining engagement. Some participants were distracted by the lack of a clear pragmatic application. However, since the table was not presented with a specific goal or context, participants felt encouraged to fill in the blanks themselves – making meaning independently instead.

We struggled with the challenge in designing ambiguous responses that emphasise the exploration of touch between people, rather than drawing too much attention to the system's actuation. For instance, we were unsure whether offering multiple touch points would encourage participants to focus on touching the tabletop instead of exploring various ways of touching the other person. Nonetheless, the participants' engagements showed a mix of exploring and speculating about different ways one can touch each other, as well as creatively appropriating the options offered in the interface of the table – such as treating the table as a DJ soundboard.

Furthermore, our project focused mainly on the exploration of ambiguity in output modalities to spark playfulness. We recognise the opportunity in doing more design explorations on the various ways one can touch another. Our system detects a binary state of touch, it detects touch or it doesn't. We believe we missed out the richness in detecting nuances and intentionality of touch. For future design iterations it would be worthwhile to delve into the sensitivity and subtlety of detecting ways of touching, and its influence on play and meaning making.

6 CONCLUSION

We present an experience in which visitors are invited to playfully explore bare-skin touch mediated through an interactive table. Inspired by previous work described by Hobye and Löwgren and informed by principles of ludic design [5], our table creates a playful setting through ambiguous combinations of sound and light in response to touch. We conducted a preliminary study with 13 couples, which highlighted the demo's potential to inspire meaning-making on touch-based interactions between participants.

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