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Hyaku: A qualitative negotiation-through-interaction interface to support runners in achieving balanced training sessions

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Hyaku: A qualitative negotiation-through-interaction interface to support runners in achieving balanced training sessions

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Abstract: Wearable systems and apps for recreational running provide awareness on one's performance and activity and aim for increased engagement. Yet, these systems focus on sensor-generated data and do little to integrate subjective and contextual factors as meaningful insights. Their interaction and feedback mechanisms mostly rely on numbers and do not always match users' real-life needs. To address these gaps, we explore human-computer negotiation as an interactive mechanism to enable recreational runners to adjust the recommendations delivered by a system. We do so by designing tangible qualitative interfaces labelled "Tradeables" (whose label is inspired by the idea of "trading" with a system). By reaching a trade-off between objective sensor evaluation and subjective feelings, we gather insights into the design of negotiation inter-faces for sport and well-being. We present Hyaku, a research artefact providing insights on the design considerations, challenges, and opportunities of tangible and qualitative interfaces for negotiation.

Keywords: human-computer interaction; qualitative interfaces; negotiation; tangible interface; recreational running.

1. Introduction

1.1 Technology for Sport Monitoring

Quantified-self systems such as sport watches, fitness trackers and mobile applications implement goals setting, data representation and/or social features to provide greater awareness of one's health, performance, and physical activity (Jarrahi, Gafinowitz & Shin, 2018), (Nelson, Verhagen & Noordzij, 2016), (Randriambelonoro, Chen, Geissbuhler, & Pu, 2015). Yet, these systems often face challenges that limit the benefits to people's health and well-being (Van Hooren et al., 2020). For instance, they do not always match people's real-life conditions or needs (Lazar et al., 2015; Vos et al., 2016; Restrepo-Villamizar, Verhagen, & Vos 2020), for instance taking into account their injury history or emotional state. Hence, people have difficulties in gaining meaningful insights from their personal data (Choe et al., 2014) and abandon the use of these devices. Furthermore, often the feedback delivered by quantified-self systems takes the form of instructions, leading users to rely on external devices for their own decision-making process (Owens & Cribb, 2019). Thus, these systems become sources of "orders" to be to accomplish a goal, doing little to provide users with genuine opportunities for autonomous action (Owens & Cribb, 2019). It is even common to find users trying to reach their daily steps goal, simply for the sake of fulfilling what their fitness tracker expects. Does this sound familiar? In these cases, the use of sports-related technologies might become detrimental, with the risk of generating psychological and physiological burdens, such as demotivation, anxiety, low engagement, physical underperformance, and overload.

1.2 Negotiation-through-Interaction

Human-human-negotiation involves complex actions of retrieving information and re-evaluating offers based on reasons given for the rejection of a previous offer (Brodersen & Kristensen, 2004). While principles of human-human-negotiation have not been widely explored in the context of design, research in the field of Human-Computer Interaction (HCI) suggest negotiation as a meaningful mechanism to enhance the way we interact with technology (Brodersen & Kristensen, 2004; Ozgur Oguz, 2012). With emerging AI-informed applications that make interacting with systems increasingly opaque, there is a clear need for humans to be able to understand and intervene in data-driven decision-making. Let us imagine negotiation principles applied to the context of sports: users could re-evaluate or reject "offers" from quantified-self systems based on sensor-generated data such as training recommendation or goals accomplishment, by considering subjective factors such as stress, motivation, or illness (Nelson, Verhagen & Noordzij, 2016; Owens & Cribb, 2019). This might increase the ability of these systems to fairly assess the condition of individuals, while enhancing the sense of autonomy and control users have over their body, and the opportunities for meaningful individual action (Randriambelonoro, Chen, Geissbuhler, & Pu, 2015; Kim et al., 2015). The Sleep Scheduler App (Erten-Uyumaz et al., 2019) for instance suggests that by imple-

menting principles of negotiation, the app can deliver more accurate and personalized feedback and predictions to support insomnia patients alleviating their condition. Leahu, Schwenk, and Sengers (2008) integrate subjective and objective experiences within a negotiation process, aimed at using the human ability to make sense of subjective factors. This helps to inform computing systems to better analyze objective measures such as raw and sensor-generated data, resulting in a better match between objective measures and subjective human experiences. Law et al. (2019) highlight the importance of negotiating and coordinating both physical and creative control when a human and a robot design together.

Social sciences produced an interesting body of knowledge around negotiation mechanisms and principles, which can be used in interaction design to shape the behaviour of interactive negotiation systems. De Dreu et al. (2007) explain that in negotiation, "parties depend on each other to acquire positive outcomes, to avoid negative outcomes, or both" and therefore simultaneously have a cooperative and competitive incentive. They define the Strategic Repertoire Principles (SRP), a set of basic principles "that covers insights into the negotiation process and captures cognitive, motivational and affective influences on the quality of agreements people reach". This taxonomy includes five strategies used in negotiation: contending, conceding, compromising, problem solving and inaction (Table 1). The Strategic Repertoire Principles allows designers to understand and research negotiation processes, in order to best shape the behaviour of non-human agents.

Table 1 Strategic Repertoire Principles (de Dreu et al., 2007)

Principle	**Definition**
Contending	Imposing one's will on the other side. Involves the use of persuasive arguments and positional commitments.
Conceding	Oriented towards accepting and incorporating the counterpart's will. Involves unilateral concessions, unconditional promises and offering help
Compromising	Involves the matching of other's concessions, making conditional promises and threats, and actively searching for a middle ground
Problem solving	Full and open exchange of information about priorities and preferences
Inaction	Part of an overarching contending strategy and used strategically to get further concessions

1.3 Qualitative interfaces

Lockton, Ricketts, Chowdhury and Lee (2017) defined the notion of qualitative interfaces and displays as "a way in which information is presented primarily through representing qualities of phenomena (*qualitative display*) and enables people to interact with a system through re-

sponding to or creating these qualities (*qualitative interface*). In the DRS theme track editorial, authors highlight that "it's qualities which help us make sense of the world" (Lockton et al., 2022a) and that numerical quantification tends to be less meaningful than richer descriptions of experiences. This idea resonates well with the gaps identified in the domain of sports technologies, where quantification appears as the default option to present information yet fails to provide meaningful feedback to users. At the detriment of balanced training, numerical feedback tends to push for more steps, more distance, more intensity. As such, the contexts of sports or preventive health have proven fruitful as an application area for qualitative interface thinking.

Previous published work presenting qualitative interfaces for recreational sports include Laina by Menheere et al. (2021a) and Asynja (Menheere et al., 2021b). Both designs address the topic of exercising motivation. Laina is a shape-changing art piece that creates a data physicalization of running routes. Asynja diffuses scents related to your previous run to trigger exercise imagery and remind you to go running again. Explorations on on-skin interfaces for injury prevention also propose a largely qualitative and embodied form of feedback (Restrepo et al., 2021). In a larger context of preventive health, we can find recent examples in the office vitality area such as Ivy (Damen et al., 2020; Menheere et al., 2020), an interactive office chair that represents sitting time through growing ivy strands, or the Office Agents (Stamhuis, Brombacher, Vos, Lallemand, 2021), a set of sensors and actuators pushing office workers to reflect on what optimal work conditions would be. Most of this work is synthesized in the recent publication of Lockton, Lallemand & Menheere (2022b).

In this paper, we integrate principles of interaction design and negotiation to explore the design of Hyaku, a qualitative interface in the context of recreational running and injury prevention. We explicitly focus on how a qualitative interface for negotiation presents itself, and how aesthetics and interaction possibilities are perceived by the users. We report insights on the concept of negotiation interaction in the context of recreational running and shed light on qualitative thinking and the aesthetics of negotiation as mechanisms to enhance interactive systems for sports and health support.

2. Designing a qualitative interface for negotiation in the context of recreational running

We followed a research-through-design process (Zimmerman, Forlizzi & Evenson, 2007) , framed around recreational running, negotiation, and interaction design. For this, the Runner's Journey (Menheere et al. 2020) offered a temporal overview of a running session and highlights actionable design opportunities for running technology.

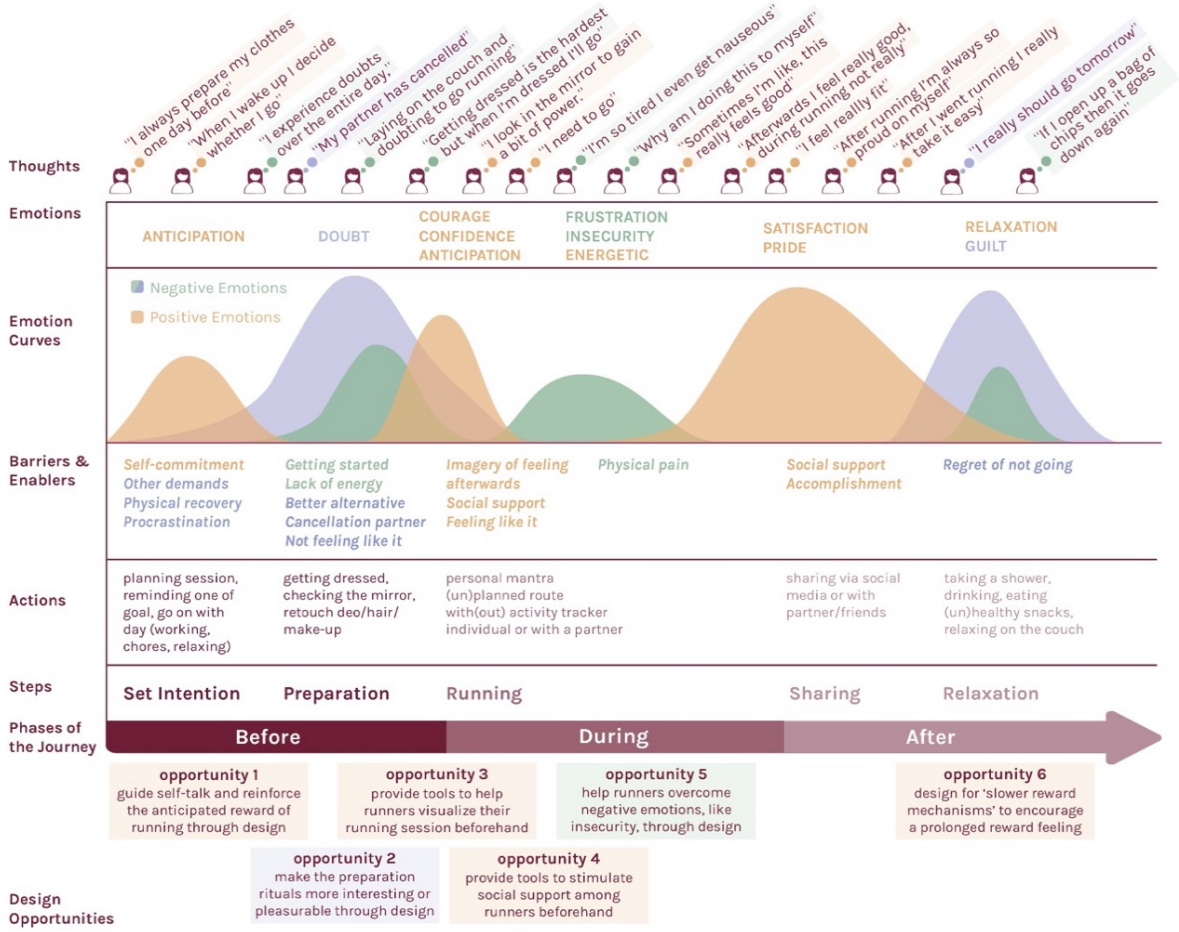

Figure 1. The Runner's Journey by Menheere et al. (2020, 2021)

Since our goal was to implement the concept of negotiation interaction in recreational running, the phase "before the running session" seemed the most adequate moment to explore. It is composed of two steps: (1) Planning: moment when decisions are made to define the nature and goals of the training session. (2) Pre-rituals, composed by actions such as getting dressed, looking into the mirror, checking the weather. The Runner's Journey also suggest recommendations focused on supporting runners in overcoming barriers or reinforcing facilitators: (i) guide self-talk and reinforce the anticipated reward of running, (ii) make the preparation rituals more interesting or pleasurable, and (iii) provide tools to help runners visualize their running session beforehand.

2.1 Defining Aesthetics of Interaction Attributes

We conducted a short workshop session with six design experts (4 males, 2 females, mean age 28 years old) have expertise industrial design, interaction design and experience design. All participants had previous experience in designing in the context of healthy lifestyle and sports technology. Two of them were recreational runners.

The objective of this session was twofold: to define the aesthetic qualities to consider in the design of a qualitative negotiation interface for recreational running, and to brainstorm on

ideas to be further be developed as prototypes. The session was divided in three stages: (i) introduction to the topic of negotiation through interaction for running (ii) use of the Aesthetics of Interaction (AoI) cards (Diefenbach, Lenz, & Hassenzahl, 2013) to reflect on and define the interaction attributes. Participants were asked to imagine a scenario of negotiating with a system about the optimal conditions for an upcoming running session. Once the participants individually defined the AoI (iii) their choices were discussed collectively. As shown in Figure 3, this led to a set of AoI to consider for designing a negotiation interface in the context of recreational running. Table 2 explains the rationale behind these choices and what they mean for a negotiation-through-interaction in the present sports context.

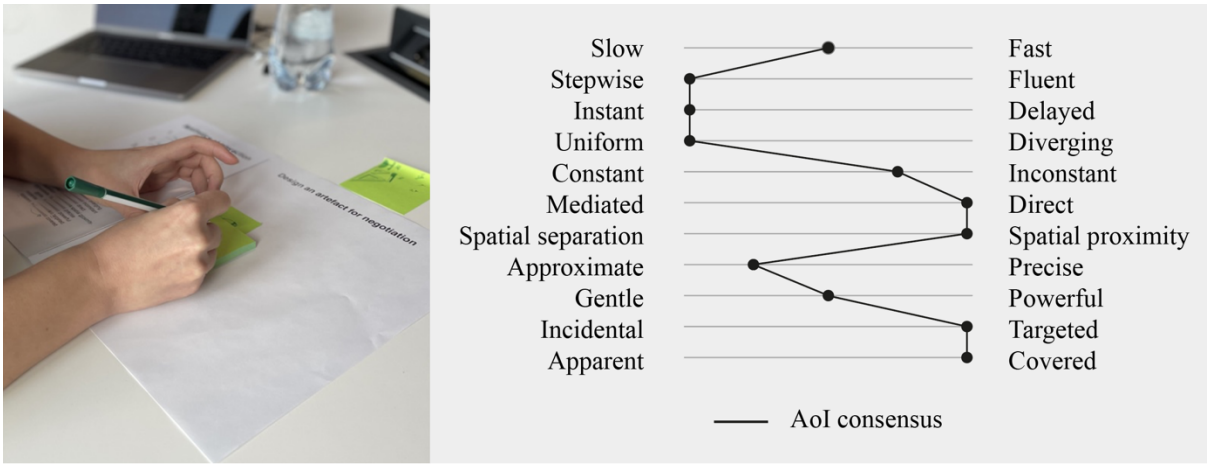

Figure 2. Set of identified AoI attributes to be considered for designing a qualitative interaction-through-negotiation interface in the context of recreational running

Table 2 Description of Hyaku's aesthetics of interaction, following the Interaction Vocabulary (Diefenbach et al., 2013) and taking into account the negotiation elements derived from the Strategic Repertoire Principles (De Dreu et al., 2007)

AoI Attributes	Rationale
Fast + Instant	The negotiation happens right before going to sport and the main goal of the user is to get out of the house to run, there is a requirement for something fast enough. The interaction will also take place several times a week.
Stepwise	The user goes through a negotiation journey, following the Strategic Repertoire Principles. The user and system will alternate between proposals and reactions until reaching an agreement.
Uniform	The device provides control modalities that are always the same, otherwise the user cannot negotiate through the interaction.
Constant	The system is constant, but the data it relies on, and the strategies used in the negotiation are complex and unpredictable by the user.
Direct + Spatial Proximity	As the context of use is related to personal health and wellbeing, the interaction takes place on the object itself, to trigger a high feeling of closeness.

Approximate	As a qualitative interface, the system leaves room for subjective interpretation of the personal data used as input for the system to define its negotiation goals. An approximate interaction style acknowledges the subjective and contextual aspects involved, and support reflection and control over potential adjustment.
Gentle/Powerful	In a negotiation process, there can be a combination of gentle (conceding) versus more powerful (contending) strategies.
Targeted	The negotiation process requires a focus of attention, the interaction should therefore targeted rather than incidental.
Covered	The interaction is covered. The device should not look explicitly like a negotiation-based sports technology. The covered aspect of the interaction reflects the dichotomy between negotiating with a supportive system and negotiating with oneself.

2.2 Hyaku: A Research-Through-Design Artefact for Negotiation Interaction

Based on our analysis of the context and definition of interaction attributes likely to support a negotiation-through-interaction, we focused on the design of an interactive artefact for negotiation.

Ideation

An ideation session through sketches allowed us to give shape to concepts inspired by the Runner's Journey (Menheere et al., 2020) and identified aesthetics of interaction attributes. We focused on the meaning of balance and negotiation in the running context, which led to numerous metaphors. Metaphors are one of the entry points when thinking of the design of qualitative interfaces (Lockton et al., 2019, see also Cila, 2013 for the use of metaphors in design research). Some metaphors were linked to artefacts, for instance the idea of balance inspired concepts using a scale or a pile of mindful stones, the idea of partner in negotiation led to concepts relying on synchronicity (of beats or music for instance). Other made us think of interaction modalities and underlying technology: power balance between actors in the negotiation process could be operationalized using force feedback as an embodiment of resistance, the idea of debt and compensation could be implemented via a mechanism of "paying back after an unbalanced negotiation" (meaning that the system would contending rather than conceding during the next interaction).

During this process, the idea of an interactive mirror (Figure 3) as a negotiation interface arose and resonated with the fact that looking into the mirror is often an action people execute before leaving home. In a running or non-running context, looking oneself in the mirror is often a moment of gratification, confrontation, reflection, or admiration. Think for instance of this sentence "If I do not train today, I will train harder tomorrow". This is an agreement often based on self-negotiation. Hence, a mirror seemed to offer an opportunity for runners to have a moment of self-negotiation through interaction just before their training. Following the recommendations of the RJ (Menheere et al., 2020), our objective with an interactive mirror was to make the preparation rituals before running more interesting or

pleasurable, and to provide tools to help recreational runners “visualize” their running session beforehand.

We designed Hyaku, an interactive mirror supporting recreational runners in defining the intensity of a training session through a negotiation interaction (Figure 3). We applied insights from AoI to inform our decisions on Hyaku’s materiality and interactive properties. Hyaku offers a tangible experience embodying Negotiation Strategic Repertoire Principles (De Dreu et al., 2007) and AoI to support runners in achieving an ideal training load. We report on the insights produced during the making process and rationale behind design choices.

Figure 1. Hyaku, an interactive mirror to support runners in achieving a balanced training scheme

Prototyping

The main interactive component of Hyaku is its frontal mirroring surface. To create this surface, we explored different options and prototyping materials. As the idea was to create a flexible mirror, we considered using a base of foam covered with reflective foil. The main issues with this implementation were its reduced ability to offer an organic and fluid deformation, in addition to the difficulty to integrate a backlight. Another potential option was to use a semi-stretchable membrane actuated and controlled by actuators. This would enable the device to move by itself in response to the user’s interaction. While this was an appealing idea to give to the user a feeling of negotiating with an independent device, technical issue arose. The main challenge was that to actuate the full surface of the mirror a complex implementation was needed, unless only a few spots on the mirror would be actuated. The last option consisted of using a very flexible membrane (white lycra) as a main substrate for the mirroring surface. This membrane would be covered with small pieces of reflective material. The first prototype was made of a flexible textile with metallic triangles glued on top. While the metallic triangles did not provide the same reflective qualities as a conventional mirror, this low-fi prototype helped to visualize the potential of the implementation. Touch-

ing a flexible mirror felt like an unexpected experience. The movement of the triangles created a distortion of the reflected image, which was an interesting idea to relate the mirror's function with a strong sense of self-image and self-control (or lack of). The prototype also helped us to envision different design opportunities to be exploited in the future, for instance the integration of a backlight that would come through the textile and the spaces generated between the reflective elements.

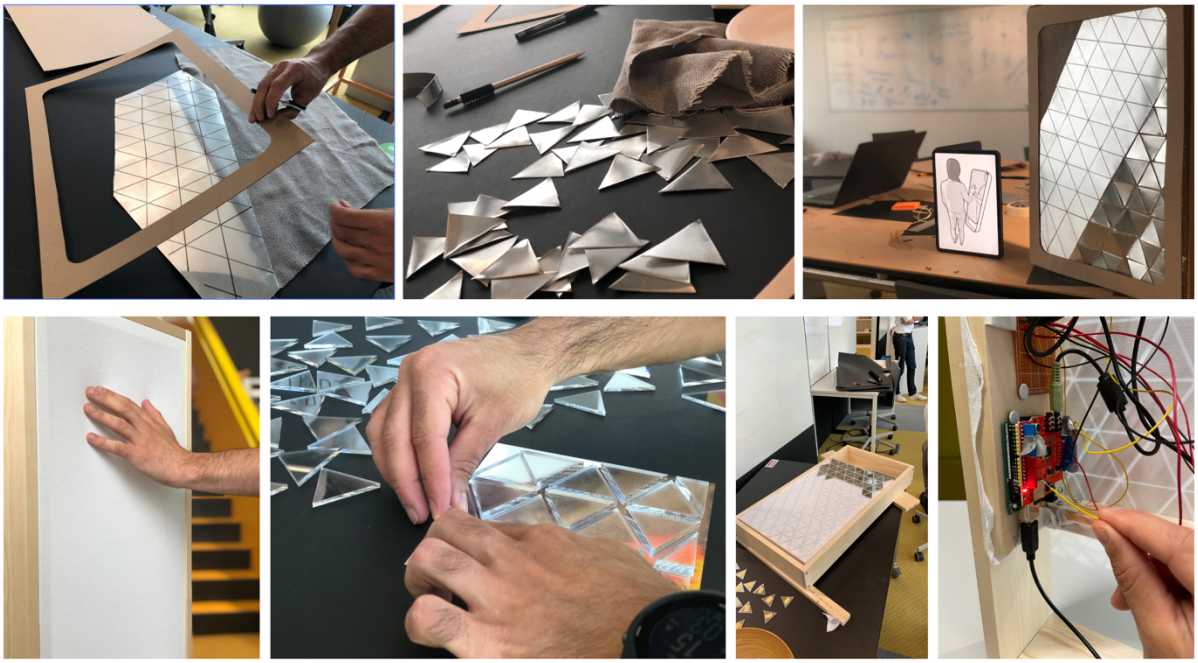

Figure 4. Prototyping activities (top line: first low-fi prototype, bottom line: functional prototype)

Based on these insights, we built Hyaku's functional prototype. For this, Hyaku's mirror is formed by a grid of individual acrylic triangles covered with a reflective foil. These triangles are glued on a flexible white textile membrane. The combination of the triangles and the membrane creates an unconventional reflective mirroring surface that offers similar reflective properties of a mirror, as well a very as a very deformable structure when touched or moved (with a sort of water texture or vibration to it). In Lockton et al.(2017) classification, Hyaku would be a level 5 qualitative interface, involving a major processing of the phenomenon to create the display. Its interaction properties, which constitute the essence of the concept to support negotiation and the input of subjective factors by the users themselves, confer to Hyaku the status of "qualitative interface" (two-ways) rather than "qualitative display" according to the definition of Lockton et al. (2017).

Figure 5. *Hyaku's technical description (left) and membrane flexibility showcase (right)*

Interaction Design and Scenarios of Use

The user must push and deform Hyaku's flexible mirror surface to communicate their desired training intensity (defined by heart-rate zones and running pace) as the focus of the negotiation moment. Hyaku emits light patterns, heartbeat sounds and haptics to expresses its "(dis) agreement" with the user's intentions. Similar to Ozgur Oguz et al. (2012), we were interested in the effectiveness of haptic and audio-visual cues in conveying negotiation related behaviors. By pushing back and forth, the user and Hyaku must agree on the ideal training intensity. Table 2 and Figure 5 show an overview of Hyaku's interactive principles and technical details. The depth of the push defines the desired intensity of the upcoming run. A deeper push equals a higher running intensity. To communicate the increase of intensity, the systems deliver sound and visual feedback. A heartbeat sound plays and increases its frequency according to how much the user pushes the surface. Light pulses are emitted in the same frequency of the heartbeat. When the system determines that, for instance, the runner is aiming for a higher intensity than recommended (based on sensor-generated data not incorporated yet in this iteration), the systems play cracking sounds to inform the user that the current choice might be detrimental for their health or fitness goals. In this regard, we found the metaphor of pushing glass to its breaking point to be a potential intriguing way to materialize the fragility of negotiation. Through this initial iteration, we explore interactive mechanisms to facilitate negotiation between users and running-related systems.

SRP	Inaction	Contending	Conceding & Problem Solving	Compromising
NI	The user can ignore system to avoid "conflicts" or to rely on their own self-regulation. This could be used by the system for future negotiation sessions and to better understand the user's behaviors.	The user express their desired running intensity by pushing the membrane. The deeper the push, the higher the intensity. The system reacts back either to agree or to desagree with the user's offer	The user either refuses to follow the system's recomendation or tries to find an agreement by pushing back to adjust intensity of the upcoming running session.	Once the user and the system find an intensity that matches the desires of the user and the objective analysis from the system, an agreement on the training intensity is achieved.

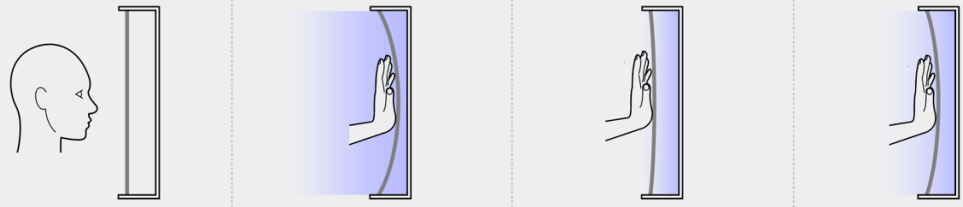

Figure *5. Scenarios of negotiation between Hyaku and a user, illustrating the five SRP strategies*

3 Exploratory User Study

The objective of this user study was to obtain insights on how Hyaku as a qualitative negotiation interface presents itself to the users, and how aesthetics and interaction possibilities were perceived by them.

3.1 Participants

Four target users (2 men, 2 women, aged 22-55) recruited via convenience sampling participated in an individual user testing session (35 minutes on average). The project was approved by the university ethical board and informed consent was obtained. Participant 1 (female, 53) and Participant 2 (male, 55) were experienced recreational runners training three times per week following a structured routine. Participant 3 (female, 29) was a novice runner without predefined running routines. Participant 4 (male, 22) was an occasional runner with experience on wearable devices for sport.

3.2 Protocol

During the test, participants were asked to interact with the device, while thinking aloud, to execute scenarios and tasks defined by the researchers. The study was composed of four stages: (1) introduction to the system, (2) free exploration session, (3) negotiation task and (4) first impression debriefing interview using the Product Reaction Cards (Benedek & Miner, 2002).

1. **Introduction**. Hyaku was introduced as “an interactive mirror aimed at supportive runners in defining optimal training schemes, not too low to keep motivation and not too high to prevent overload”.
2. **Exploration**. The participants were asked to freely explore the device (Figure 6), without being hinted about its functionality. To stimulate dialogue and actions at moments the participants seemed stuck, the researchers prompted questions such as “how would you start exploring this product?” “What would you do next?” “Why?”. At the end of this stage, participants were asked: What did you understand about the interaction?
3. **Negotiation**. Next, the participants were asked to start a negotiation process with Hyaku to define the intensity of a hypothetical running session. The researchers asked facilitation questions such as “Who do you think should start the conversation: you or the mirror? Why?” “How should (you/the mirror) initiate it?” “When is an appropriate moment to have this negotiation?” “How would you express your wishes?”
4. **Debriefing**. Finally, Product Reaction Cards (Benedek & Miner, 2002). were used to gather the participant’s first impressions regarding Hyaku. A selection of 42 cards containing adjectives was presented to the participants, asked to spontaneously pick the five cards that best described their first impression and to explain their choices.

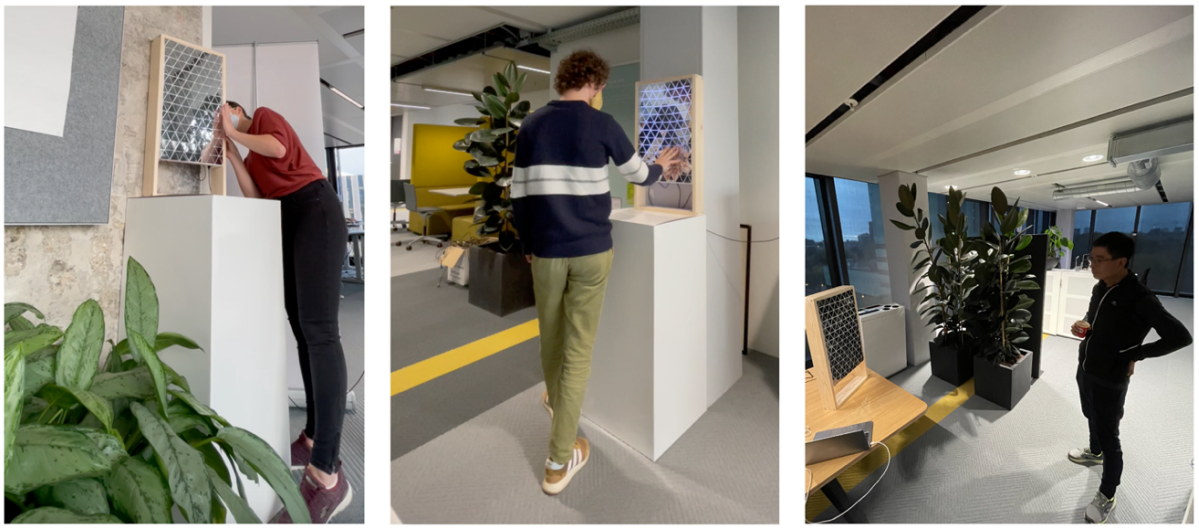

Figure 2. *Participants exploring the Hyaku prototype during the first impression exercise*

3.3 Results

During the free exploration, the participants were invited to approach, explore, and interact with Hyaku while thinking aloud. At first, all participants reported to be reluctant to touch it. They all agree on the fact that a mirror’s surface is not (usually) intended to be touched as it would leave disgraceful marks on the surface. Instead, participants would stand in front of it

and do some body movements and gestures to activate the mirror. All participants expressed the need for affordances to be triggered to touch the surface. Yet, P1, P3 and P4 were attracted by the surface patterns and touched Hyaku within 2 minutes of the free exploration stage. P2 decided to not touch it, stating that "mirrors must not be touched". Three participants checked the back of the mirror, trying to understand how to activate it.

Once the participants touched the surface, its flexible (and unusual) properties surprised them, catching their curiosity, and triggering a willingness to interact more. In a future version of Hyaku, this could be used as a mechanism to facilitate the contending and conceding phase, where the user must interact with the system to discover its negotiation power. While pushing back and forth, the participants immediately recognized the sound as a heartbeat, but did not know how to interpret its meaning. P1 and P3 related it to their own heartrate, assuming that the device was able to measure their heartrate upon touch with some form of sensors. Later, they realized that it was associated with the deformation of the mirror's surface. All the participants concluded that the harder they pressed, the higher the intensity of the heartbeat and light patterns. In a negotiation process, this might guide the user through the contending and conceding phases by discovering the possibilities and offers the system hides. P3 associated the sound of the cracking glass with an excess of the mirror's deformation, while P2 related it to woodfire, representing calories being burnt depending on the intensity of one's heartrate. Once again, values were associated to the sound, and could be potentially implemented by the user through the conceding and compromising phase, for instance easing the process of decision-making.

P2, P3 and P4 expressed confusion regarding how to use Hyaku in a running context. P1 surprisingly guessed part of the purpose of the system and said: "by touching it (the mirror), it can help me to measure my heart rate and define a proper training scheme". When asked to start a negotiation with the system, all participants agreed that the user should be the one initiating the process. They unanimously highlighted the importance to give control to the user to decide when to approach Hyaku. The contending phase should thus seemingly be initialized by the user. Yet, P1 and P4 did consider important for Hyaku to be able to start the negotiation under specific conditions, e.g., after a long non-usage period, or if the training behaviours are unhealthy. The inaction of the user might thus trigger a response from the system, so it can initiate the negotiation, probably using a contending strategy. The participants would prefer to negotiate with the mirror just before and after the training session, to check if the training was aligned with the pre-defined negotiation.

Using the Product Reaction Cards, all participants picked cards describing the system as dominantly mysterious, abstract, and dynamic. They also described it as sensorial and stimulating, attractive, caring/helpful, inspiring, surprising, yet confusing. Table 3 synthesizes participants' choices of words and underlying rationale.

Table 3 Product Reaction Cards: Synthesis of results of the most selected cards

Product Reaction Card	Participants' rationale
Mysterious	Its meaning was hidden, triggering curiosity and exploration. This might mimic the circumstances of a negotiation process, where the stakeholders do not fully know the other's negotiation power
Abstract	Its meaning is not related to its purpose and is open to interpretation. This might be hazardous, as the purpose of a negotiation process should be defined
Dynamic	Flexible and reflective surface using visual and auditory feedback. In a negotiation context this seem relevant to create a fluent process where both the system and the user can adjust their offers until agreement
Sensorial / Stimulating	Ability to stimulate three bodily senses in an "aesthetically pleasant" way
Attractive	Unusual look and feel
Helpful / Caring	Although its meaning was not completely clear, Hyaku tried to communicate something related to health and care
Inspiring	The shape-changing mirror evokes reflection and triggers interesting discussions about self-image
Surprising	The flexibility of the material is unexpected for a mirror, so are the visual and auditory feedback
Confusing	At first, Hyaku does not seem to relate to the context of use nor to its primary functionality

While only focused on the first impression, initial interaction and discovery phase, this user tests brought relevant insights into the perceptions and experiences of a (limited) sample of target users. It shed light on how qualitative properties can shape the user experience, and open opportunities to implement negotiation strategies in a usable and meaningful manner.

4. Discussion and Future Work

We presented Hyaku, a qualitative interface embodying aesthetics of interaction and negotiation principles in the context of recreational running. Using a research-through design process, we explored the design considerations, challenges, and opportunities of qualitative tangible interfaces for negotiation in the recreational sport and injury prevention context.

When designing for human-computer negotiation in the context of sports and health, it seems essential to give the initial negotiation power to the user. Letting the user initiate the contending phase might increase one's sense of control and autonomy. Even when materialized under an original shape, negotiation systems need to provide a minimum of information for the user to understand how to onboard and execute the different phases of the Strategic Repertoire Principles (de Dreu et al., 2007). The present work entails several limitations, especially the small sample size and the hypothetic scenario used in the user study. The explor-

atory user study emphasized aspects of usability and discovery, which are typical of the initial stages of interaction yet do not reflect the long-term impact that negotiated interaction can have on runners' training schemes. After a further iteration, a future study will involve an in-situ deployment of Hyaku for an extended period. In addition to this, we intend to further research the aesthetics of negotiation through experimental scenarios. By implementing different negotiation techniques, we aim to understand which negotiation style and principles would be effective to "convince" users to achieve their goal of life-training balance.

Some questions arose related to the qualitative approach used in Hyaku. In a final implementation, Hyaku would use complex quantitative data as (part of its) input. Both running data about previous training sessions (routes, intensity, duration), and the subjective data provided by the user during the negotiation, which would be quantified by the system to adjust its negotiation strategies. Hyaku as a qualitative interface therefore includes quantification behind the scenes. Further work is needed to investigate the effect of translating complex numerical data in a qualitative interface and its impact on the user experience. For instance, qualitative interfaces can add a sense of ambiguity to the data and the users might not be able to explore (quantitative) details about their training schemes. In the present case, we considered it an opportunity rather than an obstacle. It resonated with the idea of negotiating with oneself and listening to one's body rather than behaving according to numbers and prescriptions by systems not acknowledging the importance of subjective and contextual factors in injury prevention. Also, Hyaku's final prototype is envisioned to extract its input data from activity trackers or wearables, which will still be at the disposal of the users should they be interested in traditional numerical feedback. A potential scenario is that users could interpret the numerical data provided by these devices from a different, more embodied, perspective. Vice-versa, they could be curious to make sense of the negotiation interaction thanks to the numerical data displayed on apps and trackers.

Some qualitative interfaces rely on traces of use to account for the temporal aspect of a phenomenon or experience. In the case of Hyaku, the interface does not include traces of previous negotiation (or only the fingerprints of the user and perhaps the deformation of the lycra membrane over time). Is this a problem, or a missed opportunity? For instance, the system might remember the "debt" when it conceded last time, but will the user remember the debt of the system? How can the users observe progress, to encourage them in pursuing healthy habits? How can they uncover and internalize what a balance training scheme is, to regain full control rather than relying on the system in the long-term? Translating these questions back to interaction design, would it be desirable to implement intentionally made traces in a qualitative interface such as Hyaku?

Finally, Hyaku has also been the starting point of undergoing additional research-through design explorations with artefacts embodying negotiation using different aesthetics of interac-

tion (Lockton et al., 2022b). We expect that reflecting on differences and similarities between these artefacts from the "Tradeables" family will bring further insights into qualitative interface design, especially in the context of recreational sport of preventive health. In future work, we could investigate how people interpret particular metaphors (Cila, 2013) or receive particular materials (Giaccardi & Karana, 2015), for instance according to the four experiential levels described by Camere & Karana in their MA2E4 toolkit (2018).

As a conclusion, negotiation-through-interaction enables users to adjust their training schemes according to their subjective experiences and aims for enhancing the sense of autonomy and control users have over their own health. We suggest that qualitative tangible negotiation interfaces have the potential to support people with a sense of empowerment, and to some extent embodiment, of the choices offered. Through this initial work, we aim to open opportunities to explore qualitative thinking and negotiation as mechanisms to enhance human-computer interactive and quantified-self systems for sports and health support.

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