

# Affective Loop Experiences – What Are They?

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**Abstract.** A research agenda for bodily persuasion through a design approach we name affective loops is outlined. Affective loop experiences draw upon physical, emotional interactions between user and system.

**Keywords:** affective loop, affective interaction, persuasion, bodily interfaces.

## 1 Affective Loop

In my group, we have for a long time been working with the idea of an *affective loop*, involving both body and mind – inseparably – as a basis for design of embodied interactive affective systems. The idea originally came from performing a user study with an interactive, sensor-enabled, doll named SenToy built by Paiva and colleagues [13].

SenToy is a tangible doll, fitting nicely in your lap, with sensors inside its body allowing users to perform different gestures with it, see Fig. 1. The gestures influence the emotions and actions of a synthetic character in a game. The effort of performing the gestures and their shape resemble six different emotional processes: happiness, sadness, anger, surprise, gloating, and fear. For example, the movement for expressing anger is through energetically shaking the doll back and forth. The experience of doing this gesture resembles the inner experience of anger. In fact, when you perform the angry gesture as part of playing the game, you sometimes become completely immersed, through the gesture, to such an extent that you ‘feel’ the anger. Obviously, you know that you are playing a game and that you are not angry for real, but nonetheless the experience can be very strong.

But what caught our interest, when performing a user study of SenToy, was not only how different gestures could make you immersed in the game and the emotion processes of your character. We also found that users were influenced by the gestures i avatar performed on the screen. If the avatar, for example, became happy from having successfully attacked some other character, it waved its arms in the air, which was sometimes imitated by our users who waved their arms in the air in response, almost like greeting their avatar or acknowledging their identification with it.

The interaction between how the user gestured with the doll, how the avatar portrayed their input and subsequently responded to the next action in the game, as well as users’ imitation of the avatar behavior, going back and forth between user and avatar, became a strong, immersive, interactive loop. It (sometimes) helped the user to transform into being one with their avatar and his emotion processes. It seemed to us



**Fig. 1.** From left to right: SenToy doll, user study, and avatar expressing “gloating”

that the gesturing with the doll ‘opened up’ users body language, making them less inhibited, more willing to play along and be emotionally and physically involved. They became, in a sense, more bodily immersed with the situation.

Some of the gestures with the doll resembled and ‘spoke’ to users’ bodies in such a way that they even experienced the emotional process when they performed the gesture with the doll. For example, to express sadness, they had to bend the doll slowly, forwards. As users were sitting down with the doll on their lap, this meant that their whole bodies also bent over, slowly, forwards. This often made their body and face express sadness. If, on top of that, the avatar expressed sadness in a way that resembled their doll gestures, they would get even more involved in this ‘sadness’ process.

As the development of SenToy was a research project, the interaction and implementation were not always working perfectly. Sometimes the avatar did not respond quickly enough, the sensors sometimes failed, the avatar’s emotional processes were sometimes incomprehensible to the user, and so on. At those points, users would be thrown out of their embodied experience of the game. It seemed to us as if this interaction loop was very sensitive to ‘small’ interaction issues. To be seduced by the interaction required a very tightly designed, flawless loop – in particular in terms of the physical side of the interaction.

The study of SenToy intrigued us to explore this interactive loop some more. Could we perhaps create various applications, not only games, where physical gestures harmonizing with what was going on in the application would create for similar *affective loops*?

## 2 A First Definition of the Affective Loop

An important aspect of the SenToy interaction is that users choose which gesture to perform. The doll was not picking up on some automatic, physical, bodily reaction to events. Users actively chose whether to become involved and what to be involved in. This led us to a first definition of the affective loop:

- users first express their emotions through some physical interaction involving their body, for example, through gestures or manipulations of an artifact,
- the system then responds generating affective expressions using, for example, colors, animations, and haptics,

- this in turn affects users making them respond and, step-by-step, feeling more and more involved with the system

The system is not trying to infer users' emotional states, but instead involves users in an emotional, physical interactional process. Users may then choose to be involved or not – it is up to them to make the interaction unfold in ways that make sense to them. The system is only staging the scene for the activity.

This way of describing an interaction design idea is of course quite shallow. To deepen it we needed, and still need, more experience and design knowledge to tell other designers more about how to design for this kind of involvements. The research approach we choose is a practical, design-driven method where we explore the affective loop idea through building several applications. Such a process also shows the limitations of the affective loop idea: will it only be able to generate a few applications, perhaps only within the domain of games, or is this a concept that could be used for many different applications domains?

To this date, we have built four different applications: eMoto [18], Affective Diary [17], Affective Health and FriendSense. The two latter are not yet fully implemented, and so I will focus on the first two here before we come back to a new definition of the affective loop concept.

### 3 eMoto

As SenToy was a game, we decided that our next application would be in some other application domain. eMoto was created to be a mobile service for communication between friends. Mobile settings are interesting in the way they rely on interaction with a very small device, with a small screen – a 'baby' interface. To us, it seems as if this domain begs for other ways of interacting than touch sensitive screens with bad imitations of the original desk-top metaphor. We therefore decided to extend on traditional text messages by making it possible for users to make emotional gestures that would modify the text messaging using colors, shapes and animations.

From SenToy we had learnt that it was important for the gestures to harmonize with what was shown on the screen in order for users to grasp the interaction. This meant that instead of gesturing with the whole mobile phone and not being able to see the changes on the small screen, we had to find another way for the system to pick up on users' gestures. We decided to work with those mobiles that come with a touch sensitive screen and a stylus. We could then modify the stylus and add some sensors to it, rather than adding sensors to the mobile phone, see Fig. 2.

Similar to SenToy, we extracted a range of gesture inputs that resembled the inner experience of the corresponding emotional processes. The design was built on a so-called Laban-analysis of emotional body language [5]. Laban was a famous choreographer who in the beginning of the last century invented a notation system for transcribing dance and other bodily movements. The two main variables in his notation system, that made sense to our design task, were *effort* and *shape*. Effort describes the inner experience of the energy expenditure of a movement, while its form, in three-dimensional space, is described by the shape-dimension.

We reused our understanding of those two dimensions when we turned to the design task of picking colors, shapes and animations that would correspond to the

gestures. A slow inward movement associated with calmness would render slow, billowing, wavy movements of big, connected, bluish shapes, while an intense, upward directed, happy gesture rendered intense, bubbly, orange animations. The colors and shapes can be seen in Fig. 2. The high-energy expressions with fast animations appear towards the top of the circle, while the low-energy, slow shapes appear at the bottom. To the left, negative emotions are placed, such as anger and depression, and to the right, positive emotions, such as happiness or being calm. The eMoto-circle is based on Russell’s circumplex model of affect [16].

It is important to realize that the sensor-extended stylus only picks up on emotions that users choose to express – there is no automatic sensing in the stylus. Movements with the stylus will make them travel in the color circle and they can decide to stop at any time they want. It is also important to point out that the color circle does not have any textual labels explaining which parts of it is supposed to portray happiness, anger or depression. The meaning of the interaction is constructed by the sender and receiver together. It is constructed from the interaction itself – both with the system and between the two friends communicating.



**Fig. 2.** From left to right: eMoto-pen and mobile interface, eMoto interaction and color circle

The sender of an eMoto-message enters an affective loop experience when they start constructing a message to be sent to a friend. First they write the message, then they gesture with the stylus picking an area from the color circle that best describes what they want to convey, and then, finally, they send the message to their friend. The gesturing reinforces their experience of what they want to convey to their friend. To send an angry eMoto-message, they have to perform angry gestures (using high pressure and a lot of shaking of the stylus) in order to travel to a strong aggressive colorful background.

There is also, in a sense, a ‘larger’ affective loop going on between the sender and receiver of the message. As the sender is composing the message, she is, in her mind, interacting with the receiver. And when the receiver gets the message, she will realize what emotional gestures the sender has performed in order to arrive at the colorful background of the message.

In hindsight, we could probably have made this ‘larger’ affective loop experientially even stronger by adding haptics feedback to the message, so that the receiver would not only see the colorful background, but also, through e.g. vibrations, feel it.

### 3.1 Lessons Learnt on the Affective Loop

When we describe the eMoto system, people worry that the two friends will not be able to understand one-another. Maybe one of them expresses anger through picking a background from the very dark red part around 10 o'clock on the circle, while the other would choose the more energetic animations of smaller shapes higher up in the circle. We purposefully constructed the system with this in mind. We wanted the interaction to develop like a language between the two friends, where meaning would only arise from their knowledge of each other. And, in fact, our 'in the wild'-evaluation of the system with five friends using it over a couple of weeks, showed that users were indeed able to learn how the others expressed themselves and make sense of it. But the 'in the wild'-evaluation study also taught us some other important lessons. Communication of emotions between friends is not simply an information transfer problem; rather it is about physically and intellectually experiencing the whole range of emotions that make up a conversation. Friends will remind each other about their shared past, attempt to share the present, place expectations on the joint future, and attempt to express a whole range of other contextual factors that makes a social relationship. It is impossible to separate the emotion process from the overall social context or from the on-going conversation. Emotions arise from the dialogue; they are constructed, negotiated and experienced by the two friends together.

This casts a different light on designing for affective loop experiences, in particular for communication systems. Friendships can be both strong and fragile. There is a certain rhythm to the communication where we must not forget to be in touch with our friends, answer their messages, returning favors, be careful when we express negative feelings, and make sure that our friendships prosper. Friends also, to a varying degree, need to feel physically close to one-another. In a subsequent study (not yet published) on a group of very close, long-term friends, we could verify that physical closeness is very important to friends. We typically attribute physical intimacy only to romantic relationships, but they also occur between friends, even if they take on slightly different forms, like singing together or giving each other a hug.

Our initial understanding of the affective loop therefore had to be altered to reflect how emotion is inseparable from its social context. Emotion is not a state that can be packaged and sent off to a friend as a separate entity. In fact, the whole notion of broadening the information channel as a means to better emotional communication is missing this point: emotion is an embodied, constructed process – not a state that resides in some particular part of one person's brain.

Physical, bodily interaction is interesting in that it is very hard to distance yourself from it. In language-based interaction we can make use of metaphors, ironies, and in general lie about our real intentions. Such 'lying' is much harder to do in/through your body. The distance that we can create by sitting behind a screen using Facebook or instant messaging is lost.

## 4 Affective Diary

Reflections on the importance of honesty in bodily processes became the starting point for the next project. This time we wanted to switch domain again and move into the domain of personal emotional reflection. We wanted to create a diary in which

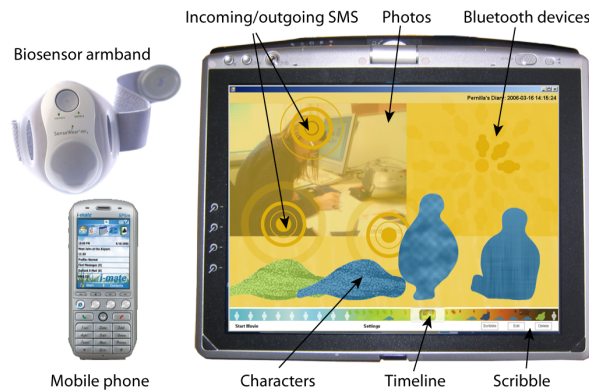
users would be able to reflect on and remember physical/bodily, experiences from their everyday lives. A diary is generally considered to be a book in which one keeps a regular record of events and experiences that have some personal significance. As such, it provides a useful means to privately express inner thoughts or to reflect on daily experiences, helping in either case to put them in perspective. Taking conventional diary keeping as our starting point, we created the Affective Diary system where users can scribble their notes, but where we also record *bodily memorabilia*, constructed from body sensor readings, and *mobile media*, (such as text messages sent/received, photos taken, etc.) collected from our users' mobile phones [17]. A premise that underlies the Affective Diary is one that views our bodily experiences as integral to how we come to interpret and thus make sense of the world.

We had been curious of bio-sensors technology and how it can pick up on various signs and signals that your body transmits when you get agitated, happy, or scared. But it seemed to us that most of the effort in using bio-sensors in the Affective Computing-field is directed at a very hard to reach, and perhaps misguided aim. Their aim is to interpret the low-level signs and signals from the body into different emotion states. In our view, providing *meaning* to emotional processes is a deeply subjective human endeavor, and we wanted to see if we could use the same technology, but involve users in the affective interpretative loop instead.

We started by carrying various available commercial sensors, including the SenseWear bracelet from BodyMedia™. While wearing those sensors, we kept diaries of events in our daily lives that seemed meaningful to us. We scribbled the diary notes and any other time-stamped memorabilia, such as emails or mobile text messages, on print-outs of the sensor-data curves. We could soon see how our own interpretation of our daily lives could be enriched by looking at pedometer data (registering your movements) and GSR (Galvanic Skin Response, measuring the skin's conductivity). While these data could not tell you exactly what you had experienced, they gave interesting indications of events that your body had experienced and most of all, the patterns arising over time revealed aspects of our daily lives to us that we might not always have been aware of.

In short, the system works as follows: as the user starts her day she puts on the body sensor armband on her upper arm and activates the Affective Diary logging system on her phone. During the day, the sensor armband collects sensor data indicating movement from the pedometer, and arousal levels from the GSR-sensor. The mobile phone logging system logs activities on the mobile phone such as SMSs sent and received, photographs taken and Bluetooth presence of other mobile phones in the vicinity.

Once the person is back at home she can transfer the logged data from the armband and the mobile phone into her Affective Diary application on a TabletPC. The armband has a wire that can be used to connect it to the PC and the mobile phone transfers the logged data automatically when docked to the PC. The collected sensor data is presented as, somewhat ambiguously shaped and colored, figures mapped out along a timeline. Above the figures, the materials from the mobile phone are placed according to when in time they arrived (see **Fig. 3**). The window shows about one hour at a time. The representation of the data can be played as a movie, animating the 'body' over time. The body will be more upright standing if the pedometer data shows that the user has been moving around a lot. If the user has been lying down, the 'body' will be lying down. The color of the character will be bright red if the GSR-data



**Fig. 3.** Affective Diary system design

indicates high arousal and then there is a color scale all the way down to blue that represents very low arousal. What we could not know from the sensor-data was whether users increased GSR-readings because of positive or negative emotions (or simply physical activity). All we could know was that they were aroused. It was therefore important that the character did not look positive or negative.

Users can scribble diary-notes on top of the materials using the TabletPC-pen, thereby connecting events to one another, interpreting the material – providing *meaning* to it.

#### 4.1 Lessons Learnt on the Affective Loop

Similar to the eMoto system, the Affective Diary system does not tell the user what their experience is or should be. The abstract, seal-like, characters that represent their bio-data are purposefully ambiguous, leaving room for interpretation. It becomes an affective loop experience, where users try to remember and re-live everyday events in order to make sense of them.

In a qualitative user study with four users, we could see that to some users this made perfect sense, while some may want much more objective, less ambiguous representations. The data from the user study suggests the Affective Diary's role in a fairly slow cycle of reflection. Perhaps surprisingly, the Diary's sparse detail — displaying time, day, text messages, Bluetooth presence and representations of physiological state—gradually became meaningful, at least at times, for the participants. What appeared to be particularly important in this process of reflection and learning was the ability to see patterns arise between their figures and the situations they found themselves in. For example, one user noted that she was always more stressed those days when she had to work from her workplace rather than working from home. Another subject noted that she was typically very calm when she was in the middle of a quarrel, but then she would typically go jogging 3 – 4 hours after the event, expressing her reactions only to herself. In short, the process built on the long-term use of the Diary and the capacity to visualize patterns and map connections over time.

In different ways, our participants' interpretations of the Affective Diary revealed that measurements read from the body are not necessarily linked to subjective experiences in

any straightforward way. Also, similar to how emotion could not be seen as an individual experience when using the eMoto-system, the Affective Diary study showed how meaning is created from a mixture of physical, emotional, bodily experiences and social context and memory of past events. What we found with the Diary is that its users ‘massage’ their collected materials into accounts that are meaningful to them.

Affective Diary is quite different from both eMoto and SenToy since it builds on autonomous body reactions rather than conscious gestures, expressing and inducing emotions. Instead users are involved in a slower, reflective affective loop where memories of past events are re-interpreted, re-lived and perhaps experienced in a new way in the light of the displayed memorabilia in the diary.

## 5 A New Understanding of the Affective Loop

Lacking from the original description of the affective loop above was a description of how our human, physical, bodies can be an arena for embodied experiences where social and bodily practices are intertwined. SenToy allows for a fast, contagious bodily experience where the user is immersed in a virtual world – a magical circle inside which the game rules, game environment and the interaction with the doll, define the experience. eMoto and Affective Diary on the other hand, are placed out in the ‘real’ world where culture, expectations and social rules determines what we can understand and how we can act. Affective Diary differs from both eMoto and SenToy in that the affective loop experience happens in a reflective process, sometime after the events that are portrayed. The experiences from building these systems have enriched our understanding of the affective loop as a basis for designing for emotional experiences. A new definition of the affective loop should therefore involve the following statements. In an affective loop experience:

- emotions are seen as processes, constructed in the interaction, starting from bodily, cognitive or social experiences
- the user is an active, meaning-making individual – the interpretation responsibility does not lie within the system
- affective loop creates for non-dualistic, non-reductionist experiences

While I have decided to focus on the three systems I have been part of building, there are of course a range of other systems both in academia and in the commercial world that we can draw upon. One very nice example is the BreakAway sculpture [10]. A sensor in the office chair is connected to a sculpture on your desk. When you have been sitting for too long, the sculpture starts slouching and looks more and more tired. If you get up and move around for a while, the status goes back to a more relaxed position. The aim is, of course, to change the behavior of sitting too long at your desk.

In the commercial world, we see a wave of tangible and haptics interaction devices, including the Wii, Guitar Hero, mobiles with accelerometers and vibrations, and various sport devices with sensors built into shoes, t-shirts and armbands. This wave of bodily interfaces, in various ways, draws upon emotional involvement.

While persuasion is not the main goal of affective loop interactions, there are some interesting similarities. Fogge’s definition of captology [8] is that it *should attempt to change attitudes or behaviors or both*. This rhymes very well with, in particular, the



Affective Diary system. By making users reflect on the connection between their bodily and social experiences, they may bridge the dualism gap and visualize the tight coupling between bodily reactions and life in general. This in turn may change their behaviors. Overall, persuasion that involves our whole being, body and mind, individual and social, is an interesting challenge.

## 6 Explaining the Affective Loop Experiences?

Above, we have hinted at some issues for the practical design processes in which we may want to make use of affective loops to get users more involved. But this does not explain what is really going on here. Where is the theory that could explain these affective loop experiences? Is it a theory on how cognition works, or can we borrow from some other discipline to explain them?

As a first step towards answering these questions, we need to question one of the fundamental dualistic perspectives in the Western culture: that of separating mind and body. In the work by Damasio [3] that underlies much of the development in the affective computing field [15], he questions whether we can at all separate emotion from thought, and emotion from body – in many cases built on findings in neurology and cognitive science. In the SenToy, eMoto and Affective Diary examples above, the designs are consciously constructed so that emotion is not separated from body nor from the overall social context. Instead, the implementation follows an *interactional* perspective on emotion. Boehner et al. [1] describe emotion as “culturally grounded, dynamically experienced, and to some degree constructed in action and interaction”. That is, emotions are created in a co-constructed, co-interpreted fashion. They are *lived*. This is why we avoid talking about emotion states and instead refer to emotions as processes. They are constructed, actively, interactively, together with others, in dialogue with our bodies, our minds and our social context.

Emotion theory draws upon many different scientific disciplines, from such varying perspectives as neurology, medicine, psychology or sociology. There is no way we can cover all these fields here, but let us provide some at least some glimpses related to affective loop experiences.

In neurology, LeDoux goes even further than Damasio and shows how fear-inducing stimuli is short-circuited directly to physical, bodily reactions even before we experience the emotion consciously [12]. In psychology, Parkinson and colleagues [14] discuss the role of emotion in social relations. While most psychologists are focused on individual and intrapsychic processes, their focus is on the social, cultural and interpersonal aspects. Just to bring out one example from their work, they discuss how emotion is contagious in interpersonal processes. One person’s tone of voice, body posture or smile, can be contagiously influencing others so that they start experiencing the same emotions. As they point out, this is not a one-shot process, but a mutual contagion. But, of course, there are regulating factors that (most of the time) stop the process from becoming a rising panic or mass hysteria. They also show how emotion is a regulatory process for bringing up children, how emotion is related to culture and how emotions align and realign interpersonal and intergroup relations.

While we agree with the overall characterization that Parkinson and colleagues provide us with, they work very much within the boundaries of traditional psychology

where the actual *subject* is lacking from the interactional process. In ethnography, the work by Katz [11], provides us with a richer account of how people individually and group-wise actively *produce* emotion as part of their social practices. When he, for example, discusses anger among car drivers in Los Angeles, he shows how anger is produced as a consequence of a loss of embodiment with the car (as part of our body), the road and the general experience of traveling. He connects the social situation on the road; the lack of communicative possibilities between cars and their drivers; our prejudice of other's driving skills related to their cultural background or ethnicity; etc. and shows how all of it comes together explaining why anger is produced when, for example, we are cut off by another car. He even sees anger as a graceful way to regain embodiment after, e.g., having been cut off by another car.

A philosophical home that many believe can have a major impact on design of bodily interfaces is that of phenomenology [7]. A phenomenological account of human cognition places us in dialogue with the world around us. Our way of thinking depends on the tools our culture provide us with as well as the social and bodily practices we learn from others. A phenomenological perspective on affective loop experiences offers a way of explaining how we create meaning from our interactions with the world. Our experience of the world depends on our human bodies, not only in a strict physical, biological way, through our *experiential body*, but also through our *cultural bodies* [9]. Physical, bodily practices are learnt in dialogue with others and our culture. Emotions are experienced through the constitution of our experiential body. Primal emotions, such as fear or anger, make our autonomic nervous system react, change the hormonal levels in our body, change our facial expressions and focus our senses and cognition, preparing us for flight or fight behavior [4]. Secondary or social emotions, such as shame or pride, crucial to our ability to maintain social relationships, also have associated corporeal processes affecting our body, facial expressions, body posture, and cognition [19].

But we do not make sense of our emotional reactions as biological processes nor are we predetermined to react in only one way to a particular circumstance. Emotion is a social and dynamic communication mechanism. We learn how and when certain emotions are appropriate, and we learn the appropriate expressions of emotions for different cultures, contexts and situations. The way we make sense of emotions is a combination of the experiential processes in our bodies and how emotions arise and are expressed in specific situations in the world, in interaction with others, colored by cultural practices that we have learnt. Designing for embodied representations of emotional experiences should thus ideally relate to and build upon both the experiential and cultural body.

But what is lacking from the glimpses I have provided here from range of different scientific disciplines is the actual *subjective experience* of interacting with SenToy, eMoto or Affective Diary. In a sense, the perspectives provided by neurology or psychology as discussed above, convey a reductionist idea – that it is possible to understand human thinking and sense-making if we only model enough of the signs and signals our bodies sends in the neuro-system or convey between people through their facial expressions, tone of voice, etc. Designing systems is also an art-form that recognizes human beings as something else than machines built in wet-ware. To get at those aspects, we might have to turn to the humanities or arts to get proper inspiration. Our subjective experience of being involved in affective loops is, in this perspective,

difficult to define and measure, and perhaps should not be in any simplistic sense. Affective loop experience is in that sense similar to concepts such as aesthetic experiences, subjectivity or *gameplay* in games; you know when you experience them, but they cannot be divided into their subparts and analyzed as separate entities that can then be added together as in an equation, calculating its ‘experience-value’ [6].

## 7 Questions

Digital products that attempt to set the scene for emotional experiences, bodily interactions, persuasive processes, aesthetic experiences and other experiential qualities, are gaining grounds both in the commercial world and in the so-called “third-wave of HCI”-movement within academia. This movement places some hard questions to us as researchers. Above, I have hinted at questions specifically related to affective loop experiences, such as:

- what kind of knowledge can we gain on how to design for affective loop experiences?
- is the affective loop design concept able to generate a whole class of systems and what are those?
- how can we explain the physical, emotional, social and subjective experience of being inside this kind of involving interaction?

On a meta-level, the whole movement of third-wave HCI is facing a range of very difficult methodological challenges as it is in a way a paradigm shift [2]. By which methods can we capture and discuss subjective experiences? To avoid reductionist ways of accounting for subjective, aesthetic or indeed affective loop experiences, we do believe that it is possible to find a middle ground where we can actually speak about qualities of experiences and knowledge on how to design for them without reducing them to something less than the original. This does not in any way mean that the experiential strands, or qualities, are universal and the same for everyone. Instead they are subjective and experienced in their own way by each user.

A new kind of rigor in research is called for when we start mixing these kinds of design issues with more scientific endeavours of understanding human emotion and persuasiveness. Producing (design) knowledge in this area may feel like a daunting task as the qualities we strive to capture are highly elusive, subjective, context- and application-specific, and relates to values such as aesthetics, fun, meaning-making or being emotionally close to others. But this does not free us from figuring out a way to address this field.

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