

Exploring Situated & Embodied Support for Youth’s Mental Health: Design Opportunities for Interactive Tangible Devices

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The ability to manage emotions effectively is critical to healthy psychological and social development in youth. Prior work has focused on investigating the design of mental health technologies for this population, yet it is still unclear how to help them cope with emotionally difficult situations in-the-moment. In this paper, we aim to explore the appropriation, naturally emerging engagement patterns, and perceived psychological impact of an exemplar interactive tangible device intervention designed to provide in-situ support, when deployed with n=109 youth for 1.5 months. Our findings from semi-structured interviews and co-design workshops with a subset of participants (n=44 and n=25, respectively) suggest the potential of using technology-enabled objects to aid with down-regulation and self-compassion in moments of heightened emotion, to facilitate the practice of cognitive strategies, and to act as emotional companions. Lastly, we discuss design opportunities for integrating situated and embodied support in mental health interventions for youth.

CCS Concepts: • **Human-centered computing** → **Empirical studies in HCI**; Haptic devices; • **Applied computing** → *Health informatics*.

Additional Key Words and Phrases: mental health; youth; situated support; embodiment; tangible interaction; emotion regulation

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1 INTRODUCTION

Mental health is a topic of utmost importance to public health, with recent reports indicating that youth have the highest prevalence of mental illness among other age groups: half of lifetime mental health disorders are established by age 14 [109], and three quarters by the mid-20s [61]. In the UK, for example, one in eight youth have a mental health disorder and one in four young women aged 17-19 have significant depression or anxiety, with half of those having self-harmed [30] and one in four having suicidal ideation [64]. The consequences of not addressing youth mental health conditions extend to adulthood, impairing both physical and mental health and limiting opportunities to lead fulfilling

lives as adults. However, less than a third of all youth with mental health disorders receive any treatment [30, 93], creating a need for scalable solutions that can offer emotional support when and where youths need it most.

To address these challenges, a growing body of HCI and Psychology research focuses on exploring the design and implementation of technology-enabled mental health interventions for youth (cf. definition of youth used in this paper [106]), with one arm of this work looking specifically at how to support the development of adaptive emotion regulation skills [35, 69]. Emotion regulation—the ability to effectively modulate one’s emotional states—has been shown to be a protective factor that can prevent or mitigate mental health conditions [2, 6, 32, 111]; and is increasingly viewed as a fundamental life skill associated with wellbeing, academic performance, and positive adjustment throughout the life span [11, 43, 71]. As a result, emotion regulation interventions have been suggested as one of the few transdiagnostic treatments across mental health disorders for youth and adults alike (see [32, 34, 89, 96] for recent reviews), and are at the heart of many traditional clinical interventions. Most commonly, these intervention approaches rely on the explicit teaching of skills during sessions with scaffolding from the trainer/practitioner, and subsequent attempts by the learner/patient to apply these skills in their daily life. In this regard, an emerging area of scholarship is investigating how to facilitate the teaching and practise of emotion regulation skills with digital technologies [80, 81, 107], with the goal of empowering youth to learn and practice constructive coping strategies outside of formal psychotherapy (e.g. in between therapy sessions or via self-guided supports). Nevertheless, one of the open challenges in this space is the lack of intervention delivery mechanisms (digital or other) that can effectively support the youth when having to cope with emotionally difficult situations in-situ.

In this paper, we draw on literature in embodied cognition and tangible interaction to explore the potential of *interactive tangible devices* as a way of enabling *embodied, ongoing, in-the-moment support* to help youth cope with emotionally difficult situations in their everyday life. We report on the deployment of an exemplar interactive tangible device for emotion regulation with a total of $n=109$ youth (i.e. adolescents aged 16-24, and university students) for about 1.5 months; including semi-structured interviews and co-design workshops with a sub-sample of participants ($n=44$ and $n=25$, respectively). In doing so, our aims were two-fold: (1) to learn about the perceived psychological impact, contexts of use, and engagement patterns of youth with such an exemplar interactive tangible device for emotion regulation; and (2) to explore more broadly how these findings can help us understand new possible design opportunities for situated and embodied interventions for youth’s mental health.

Our findings suggest that technology-enabled objects can offer unique opportunities to support youth’s mental health in-situ, especially as a potential bridge between the physical and cognitive strategies that are commonly used for emotion regulation. Most of our participants found benefits of using the exemplar device as mental health tool that provided tangible and concrete support on-demand, during stressful or overwhelming situations in their everyday life. We argue that the physicality and tactile affordances of interactive tangible devices could serve as an innovative delivery mechanism to provide in-the-moment support. We conclude the paper with a discussion of the observed themes, and abstract them into broader design considerations for embodied interactions and situated mental health interventions.

2 RELATED WORK

2.1 Youth’s Mental Health Technologies

While youth are most at risk of developing mental health conditions, they are also the least likely to seek support [93]. Therefore, the design and development of technology-mediated psychological interventions for youth have received increased attention as a potentially interesting avenue to have a positive impact, since digital resources are already an

integral part of youth's everyday lives [41, 45]. In this regard, many evidence-supported interventions focus on training emotion regulation [3, 95, 96], a fundamental life skill central to the development and maintenance of a range of mental health conditions such as anxiety, depression or eating disorders.

In Clinical Psychology, emotion regulation approaches have been suggested as one of the few known transdiagnostic treatments across mental health disorders (see [6, 32, 34, 75] for some of the latest reviews) and are at the heart of many traditional clinical interventions, such as Cognitive Behavioural Therapy (CBT) [16, 108] and Dialectical Behavioural Therapy (DBT) [22, 86], as well as body-based interventions, such as mindfulness-based interventions (MBIs) [37, 91]. However, the lack of scalable and effective approaches that would enable adolescents to transfer skills from training sessions to their everyday life is one of the core challenges across therapeutic and preventative contexts. For example, although home practice is a core component of MBIs and learners are traditionally encouraged to engage in daily home practice to incorporate the skills learned during sessions into their daily lives, adolescents tend to exhibit low compliance with home practice recommendations [17, 85], which has been found to limit intervention impact on outcomes [18, 52, 58]. While technology-enabled interventions have been suggested as a possible solution to these issues, it is still not clear how to design for such situated support, nor is the literature clear on which digital technologies are best positioned to support youth in particular.

Both in HCI and Psychology, a common approach has been investigating how technology can support cognitive or talk-based interventions [33, 45, 90], as a means to make traditional interventions easier to access and more appealing to engage with for youth [40]. Most of the work in this space is centred around the design and implementation of *computerised Cognitive Behavioural Therapy* (c-CBT) [20, 25], a structured intervention focused on information-processing that has strong evidence supporting its effectiveness for youth's mental health. Youth-focused c-CBT approaches often draw on the use of therapeutic games to improve mental health awareness and reduce the stigma associated with seeking mental health support (e.g. Reach Out Central [15]), support therapeutic activities between clinical sessions (e.g. Treasure Hunt [14]), or facilitate face-to-face clinical interventions (e.g. gNATS Island [26]). In addition, self-tracking interventions have also received increased attention due to their potential to foster self-awareness in-the-moment [21, 60]. For instance, using mobile or wearable technologies to deliver reminders and recommend information around emotions and their associated features [45, 112]. Recent HCI work in this space has explored the design of more delivery mechanisms beyond screen-based technologies, for instance, using haptic patterns [24, 70, 82, 105].

In conclusion, most research on digital mental health interventions has concentrated on information-delivery psychoeducational approaches (e.g. symptom and mood monitoring, delivering theoretical information), and only a limited body of work has looked at placing the action at the centre of the interaction by providing in-the-moment and ongoing support to scaffold the practice of regulatory skills (e.g. Intellicare [72], PIV [70], BoostMeUp [24]).

2.2 Tangible and Embodied Interactions for Situated Support

Tangible and embodied interaction is a well-established research field in HCI that focuses on the implications and new possibilities for interacting with computational resources within the physical world while supporting intuitive use [48, 62]. Drawing from learning theories and embodied interaction, tangible and embodied interactions have been shown to benefit learning and the development of skills [66–68, 110]. The manipulation of physical objects allows offloading cognition by freeing up valuable cognitive resources during problem-solving [66], and the physical properties of a physical object can be made to correspond perceptual information using conceptual and embodied metaphors [8, 53, 54].

A common characteristic of tangible devices is their natural affordances of providing people with support that fits and connects to their immediate learning environment and context [63]. In this regard, HCI work has explored the role of different interaction modalities with tangible objects to provide situated and embodied support. For example, to facilitate the teaching of abstract concepts using embodied metaphors [5, 8] or to promote the adoption of healthy habits with tangible representations of physical activity [73] in children; as well as in healthcare facilities to stimulate social connections for people with dementia using metaphorical sounds [49], or to promote engaging with therapeutic activities for women living with severe mental health conditions by using colour-based representations of emotions [102].

An exemplar body of work that has used tangible objects with multimodal feedback—including audiovisual and haptic interactions—is that which exploring socially assistive robots (SAR) [59]. Motivated by the promising effects of human-animal therapy interventions, SARs rely on embodied metaphors and tactile interactions to replicate the diverse emotional benefits that companion animals offer people (see, e.g. [7, 36, 57] for reviews). Much of the work on SAR interventions focuses on older adults suffering from dementia [47, 74, 87] or depression [99] and autistic children [23, 29], with only a handful of studies exploring the relationship between youth and SARs [13, 76, 79].

Finally, recent HCI research has suggested employing a simple SAR as a novel approach to teach emotion regulation skills to children [55, 97, 98]. Differently to common top-down and module-based clinical psychological interventions, researchers have explored having an interactive tangible device as the main vehicle of a bottom-up, in-situ and child-led intervention i.e. Purrble [55, 97, 98]. We argue that such an approach could be a potentially interesting design direction for youth, as it offers the possibility of providing situated and embodied support and can be embedded in their daily lives. However, Purrble has been designed for a younger population with a range of child-friendly features, thus it is not clear whether and how it would be useful for older youth, and what design features would be shared or unique across age groups.

3 METHODOLOGY

The work presented in this paper is part of a larger study that aims to investigate in what ways technology-enabled objects can promote mental health by providing situated and embodied support. To this end, we chose to use a commercial device that had been originally designed to support in-the-moment emotion regulation for children (Purrble¹), as an exemplar technology-enabled object to explore this design space with and for youth. According to previous research (cf. [55, 97, 98]), the interactions were designed with the aim to impact two separate stages of the emotion regulatory process: the attentional deployment stage [3, 37, 95], by shifting the attention from the emotion-eliciting situation towards interacting with the device, and the response modulation stage, by facilitating down-regulation through pleasant tactile interaction, analogously to the mechanisms assumed to underpin emotion regulatory effects of human-animal interaction [9, 12, 27, 77, 78]. The full description of the design process and the intervention theory of change is available elsewhere (cf. [55]).

Study structure. This paper reports on a two-step study exploring the potential of using an interactive tangible device to support youth cope with emotionally difficult situations in-the-moment. Specifically, we started with initial deployment with a small subset of adolescents (n=31) to explore appropriation and perceived effects of Purrble. Based on positive results, we then scaled up to a larger deployment with university students (n=78) to gain a more in-depth understanding of this design space.

¹<https://www.purrble.com/>



Fig. 1. Interactive tangible toy used in this study as an exemplar technology-enabled object for emotion regulation: Purrble

The methodology used in both deployments was very similar (see Figure 2 for research timeline):

- (1) As a first step (cf. Section 3.2), we deployed the exemplar device with youth ($n=109$) for about 1.5 months and we ran a series of semi-structured interviews with a sub-sample of the participants (25/31 adolescents, 19/78 university students) to learn about their experiences with Purrble.
- (2) As a second step (cf. Section 3.3), and drawing from the deployment's findings, we ran a series of co-design workshops (with $n=11$ adolescents and $n=14$ university students) to explore more broadly potentially interesting design opportunities for situated and embodied interventions for youth's mental health using an interactive tangible device.

In what follows, we offer an overview of participant recruitment methods and demographics, as well as the research methods used in the two-step study and ethical considerations.

3.1 Participants

We now provide an overview of the demographics and recruitment methods for the two representations of youth recruited for this study: adolescents and university students.

3.1.1 Adolescents. We recruited 31 adolescents to take part in a six-week study on their engagement with Purrble, specifically focusing on youth who might either have lived experience with mental health challenges or have shown interest in the domain. Participants were recruited from Youth Advisory Groups (YPAGs) around mental health, a charity for mental health research [31, 65], and snowball sampling. However, in the end, only 25 adolescents (aged 16-24 years; 24 female, 1 male) arranged a time with the research team to participate in the semi-structured interviews—and thus in the findings, we will only report on this sample. To appropriately compensate for adolescents' time, participants were informed that they would receive £20 after the completion of each research activity (see 3.1.2) and would have the opportunity to keep the Purrble after the study if they wished (market value equal to £40).

3.1.2 University Students. Through the University's welfare newsletter, we disseminated a flyer with information about the study and within 7 days a total of 300 students expressed their interest in participating. Due to the limited number

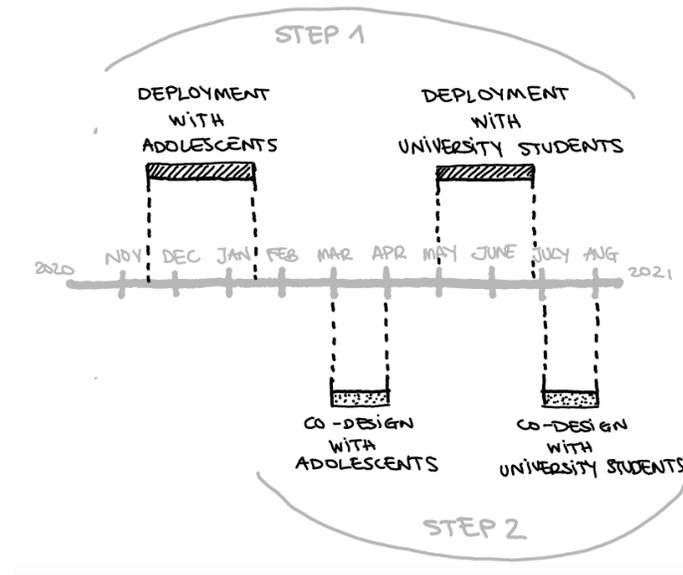


Fig. 2. Research timeline of the two-step study presented in this paper, including deployments and co-design work with adolescents (November 2020–April 2021) and university students (May–August 2021).

of devices available for the study ($n=80$), we decided to include those who we hypothesised would be the most in need and/or populations underrepresented in previous related work. This decision was based on preliminary data from Step 1, in which we found that those who were struggling with anxiety or high levels of stress seemed to benefit from Purrble the most. Therefore, we initially selected those students who reported having a higher generalised anxiety level in the expression of interest survey (i.e. GAD7 score > 10 [100]²). Then, from the 142 students that fit the inclusion criteria, we invited all the non-female (18 male, 13 non-binary/third-gender) –as they had been under-represented in Step 1– and the 49 females with higher reported anxiety (GAD7 score ≥ 14). A total of 78 participants volunteered to participate in the study (43 undergraduate students, 37 postgraduate students). As discussed with the University’s mental health services, participation in the main research activities during the 7-week deployment was voluntary, and participants were given a Purrble to keep as compensation for their time. However, the participation in additional research activities after the deployment (e.g. co-design workshops, see below) was compensated with a £20 Amazon voucher.

3.2 Step 1: Exploratory Deployments

In Step 1 of this study, we deployed an interactive tangible device—i.e. Purrble—with two youth groups who might either have lived experience with mental health challenges or have shown interest in the domain (see Section 3.1 for recruitment approaches).

In both deployments, all participants were sent a Purrble with its original packaging, and the only instructions of using it ‘as much or as little as they liked’. This was to ensure we could gain an in-depth and unbiased understanding of how youth appropriated and engaged with such an interactive tangible device over time. The initial 6-week deployment with 31 adolescents indicated that young adults, and particularly those struggling to manage their emotions due to

²GAD7 scores: Cut points of 5, 10, and 15 might be interpreted as representing mild, moderate, and severe levels of anxiety.

being under a lot of stress or struggling with mental health conditions such as anxiety, were found to benefit from Purrble the most. Based on this, we decided to run another study with a young and anxious population to gain a better understanding of *if* and *how* the exemplar interactive tangible device could provide in-the-moment emotion regulation for youth. Thus we deployed Purrble with 78 university students during the last academic term (7-weeks).

We now provide an overview of the research activities conducted in each of the deployments, and the data collection and analysis methods.

3.2.1 Research activities with adolescents: interviews mid- and post- deployment. To understand their experience with Purrble, all participants were invited to *semi-structured interviews* at two points of the study: week 2 and week 6 after receiving Purrble. The interviews with the adolescents who agreed to participate (n=25) took place over Zoom³ and lasted 45-60 minutes. The interviews' topics centred around Purrble: initial thoughts and expectations; appropriation; friends' and family's reaction; if and how they had used it and what (if anything) helped them; if they could see any problems from its use; what they liked and didn't like about having Purrble, and what they would change about it; if they thought they would continue using it after the study.

3.2.2 Research activities with university students: post-deployment survey and interviews with sub-sample. Throughout the 7-week deployment, all participants (n=78) were asked to complete simple surveys on Qualtrics⁴. In this paper, however, we only report on the qualitative data collected in the survey completed on the last week of the deployment (answered by 75% of participants)—as the rest is beyond the scope of this paper. This final survey explored the perceived effects, the evolution of engagement patterns over time, and the main contexts of use. Moreover, to gain a better understanding of their experience with Purrble, we invited a subset of participants (n=54) to participate in *semi-structured interviews* after the 7-week deployment. This was a representative sub-sample selected using a stratified sampling approach to ensure that it reflected the diversity of the sample, considering: participants' initial anxiety score (cf. Section 3.1), engagement with Purrble, and perceived impact on their mental health. The interviews took place over Zoom with those participants who agreed to participate (total of n=19; n=12 identified as women, n=4 as male; n=3 as non-binary/genderqueer; n=10 were undergraduate students, n=9 postgraduate), and lasted 20-30 minutes. As with the adolescents, the interview's topics centred around their experience with Purrble: initial thoughts and expectations; if they would have liked to receive any additional materials; if they thought it could be useful for people their age; in what situations (if any) they found it to be consistently helpful/not helpful throughout the deployment; how and why they thought it helped/not helped in those situations; if they used any other strategies to regulate their emotions, and how the effects were similar or different to those of using Purrble.

3.3 Step 2: Co-design Workshops

In Step 2, we aimed to understand how to design situated and embodied support for youth. To do so, we combined the findings from Step 1 and use Purrble as a proof of concept in a series of co-design workshops with a subset of participants from each of the deployments in Step 1 (see 'Participants' for recruitment approaches) to explore what additional resources and characteristics such a device would need to have if designed for youth. During the co-design workshops, the participation was pseudo-anonymous to make participants feel more comfortable in sharing views and discussing ideas around mental health: they were invited to use nicknames in gather.town and all the interactions on the Miro board were anonymous (see Figure 3 for an example)—besides those from the researchers. Interestingly,

³<https://zoom.us/>

⁴<https://www.qualtrics.com>

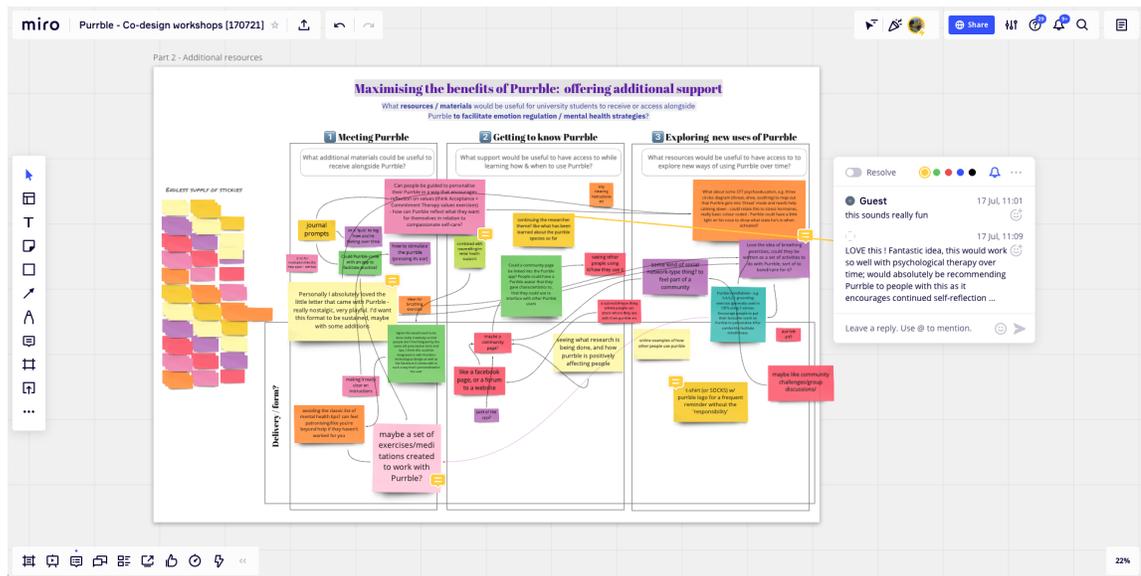


Fig. 3. Example of a Miro board from a co-design workshop with university students: participants added post-its, arrows and comments to discuss ideas anonymously on the board.

most interactions and group discussions happened on the Miro boards by placing post-its, linking ideas and adding comments (Figure 3), rather than talking between participants. We now provide an overview of the methods used in the co-design workshops with youth, and the data collection and analysis methods.

3.3.1 Co-design workshops with adolescents. After the 6-week deployment, all participants were invited to participate in a remote *co-design workshop* to explore how they envisioned Purrble could be best framed and used for people their age. We conducted 3 workshops remotely using gather.town⁵ and Miro⁶, with a total of $n=11$ participants who agreed to participate (all identified as women; $n=5$ were 16-18yo, $n=6$ 19-24yo). Each session had 2-5 participants and lasted around 2 hours. The workshops followed a user-centred approach in which the participants were asked to discuss creative and playful imaginations of how Purrble could be most appropriately framed and presented for youth by placing stickers on semi-structured Miro boards. Building on the interviews data, each session focused on exploring: the motivations for getting Purrble and first impressions; what would be specifically beneficial strategies and contexts of use; what would be needed when designing a new 'Purrble experience' for a friend.

3.3.2 Co-design workshops with university students. Those participants who agreed to be contacted for additional research activities ($n=35$) were invited to participate in a remote *co-design workshop*. Similarly to those in Step 1, the workshops were grounded in the deployment data and followed a user-centred approach to explore how participants thought Purrble could be best presented to university students, and what additional resources they would find beneficial to receive alongside Purrble. The workshops ($n=4$) took place on gather.town and Miro with a total of $n=14$ participants ($n=7$ identified as women, $n=2$ as men, $n=5$ as non-binary/genderqueer; $n=8$ were undergraduate students, $n=6$ postgraduate). Each session had 2-5 participants and lasted around 2 hours.

⁵<https://www.gather.town/>

⁶<https://miro.com/>

3.4 Ethical considerations

Throughout the study, the research team had ongoing engagement with psychologists to discuss and validate the recruitment materials, methods, findings and future research directions. Prior to any data collection, the study's research activities were approved by the university's Research Ethics Committee and informed consent was obtained from all individual participants. Because of the Covid-19 pandemic, all the research activities were conducted remotely at times convenient for the participants.

4 EXPLORING YOUTH'S APPROPRIATION AND PERCEIVED IMPACT OF AN INTERACTIVE TANGIBLE DEVICE

In this section, we report on the key themes that emerged from our analysis from the exploratory deployments with youth. We start by providing a general overview of how Purrble was used across the population—both deployments with adolescents and university students—and the overall perceived impacts. Then, we describe how youth's engagement changed over time as they discovered the contexts in which Purrble was most useful for them, and what mechanisms were found most helpful to foster repeated engagement. Finally, we detail the most meaningful strategies that youth disclosed using around Purrble, including using the device as a tangible anchor to facilitate the practice of cognitive strategies and as a compassionate emotional coach. Furthermore, although the findings are framed around the use of Purrble, we also illustrate how the interactive and physical affordances of such an exemplar tangible device inform the broader research of question of how to design situated and embodied support for youth's mental health.

As mentioned above (cf. Section ??), since the findings from both deployments mostly overlapped, we have combined them and they are reported together in this section. We clearly specify any instances there were any differences between adolescents and university students. To protect anonymity, participants are referred to by using A for 'adolescent' and U for 'university student' from the respective deployments, followed by a participant number.

4.1 General Overview

Throughout both deployments, all participants reported having repeated interactions with Purrble, and most of them found it had a positive impact. Regarding their motivations for regularly engaging with the tangible device, most participants from both deployments found Purrble particularly useful as a way to calm down in moments when they felt 'anxious', 'stressed', or 'overwhelmed'. In particular, youth found it notably useful to help them manage heightened emotions related to school—and university—work, loneliness, and insomnia.

In describing how they felt after interacting with Purrble, the words we most commonly heard from adolescents were 'calmer', 'happy', and many shared the view that interacting with the toy was soothing: "*it just feels peaceful*" (A14). Similarly, from those university students who completed the final survey (56/78), the majority (95%) reported having interacted with Purrble regularly as they found it to be a very 'comforting' and 'grounding' tool that helped them anchor their attention and calm down. In addition, nearly two thirds (62%) stated that having Purrble had helped with their mental health: "*I'm in a difficult time submitting my thesis and I'm very anxious about many things, there is no easy way to manage it except taking pills—which I had been doing a lot—, and [since having Purrble] I've actually reduced taking medicine*" (U9). The minority of university students who did not find Purrble beneficial seem to have rarely engaged with the device, mostly because of perceived stigma or lack of appeal, as explained by this university student in the final survey: "*I rarely used it [...] I felt self-conscious being an adult woman cuddling a robot*".

In what follows, we focus on the qualitative data from the interviews with youth to illustrate the main findings on the appropriation, perceived impact and main beneficial strategies that emerged from engaging with the exemplar device.

4.2 Engagement Patterns Over Time and Perceived Impact

In this section, we describe how youth's engagement with the interactive tangible device evolved over time, grounded in three interrelated facets: discovering beneficial contexts of use over time; the impact of having an embodied, tactile tool; and the mechanisms youth adopted to foster repeated engagement.

4.2.1 Discovering contexts of use. When looking at the engagement with the tangible device over time, we saw a common pattern where youth started with a trial-and-error approach to explore how and when to interact with Purrble, and moved towards more purposeful use when they determined in what situations it would work best for them. First, about two-thirds of our participants reported joining the study to explore if Purrble could be a useful solution to help them manage emotions, whereas the other third joined out of curiosity. While the former group used it consistently throughout the deployments, in the latter the engagement seemed to taper off after the first couple of weeks.

For those who used Purrble for emotion regulation, the repeated interactions with Purrble appear to have been driven largely by its perceived effectiveness. Most of these participants report valuing Purrble, and being reassured by having "something in place, kind of a safety net" (A4) that they could access if and when they needed help. In particular, this was often mentioned by those who disclosed living with a mental health condition. As a result, most common contexts of engagement were at home, especially in their bedroom, as using Purrble was perceived as an intimate and vulnerable practice.

"Having this concrete sort of object that I associate with a time where I just sit down and spend some time calming down if I'm stressed. [...] A bit after I've got him I started using him for when I was falling asleep and has helped me fall asleep instead of thinking about everything that I had to do the next day or everything that I did the day before. I just sat there and is just his gentle purring and feeling the texture of the toy, it was like really really nice to have something that kind of unhooked my thoughts to something else. That was something new that I did not have before" (U13).

Regarding their motivations for engaging with the tangible device, they found Purrble particularly useful as a way to calm down, as illustrated by the above quote. A primary source of many youth's stress or anxiety related to school or university work: *"I really enjoyed having Purrble. [...] Particularly during online lectures, when something is a bit confusing and I'm not sure what is going on, I just get Purrble, put it on my lap and just stroke it because it's quite soothing."* (U5). But several participants also found it useful to help them sleep and to manage loneliness.

Finally, another factor that influenced the frequency of use was changing personal circumstances, especially in as much as these affected the range and severity of stressors youth faced. For instance, due to a change in national Covid-19 restrictions, most participants moved into lockdowns and from face-to-face to online learning during the deployments, which they reported led them to engage with Purrble more regularly as they struggled to be apart from their friends and family: *"if you are just feeling lonely or homesick [...] this might remind you of your pet and help you feel less distanced from them"* (A8). Conversely, during school or university holidays, both adolescents and university students mentioned using Purrble less as they had fewer stressors.

4.2.2 Impact of physicality and embodied interactions. As described above, the majority of our participants found Purrble's embodied interactions to be soothing and calming. In this regard, youth commonly referred to the physicality of the device as a key aspect from which effects emerged.

"I do feel it is as though as you're stroking it, you calm down and then it calms down and then that makes you calm down a bit more. And then it calms down a bit more. That way it gradually works. It's clever because it makes you feel like you're doing something to calm this thing down and it's working and so you gradually calm down because it feels like reciprocity or you're synchronising almost." (A12)

Participants commonly described how using Purrble "grounded" (A16) them in moments they felt stressed or anxious, enabling them to pull away from negative or challenging emotions and thoughts, and to refocus on what was happening in the present moment. For these participants, controlling their racing thoughts was key to the perceived benefits of interacting with the embodied tangible device: "When I first get anxiety, my thoughts race and everything is going around in circles. It has interrupted that" (A6). More specifically, youth found the tactile affordances to be very soothing, which many had not anticipated.

In particular, it was the rhythmical, "systematic motion" (A2) required to soothe Purrble combined with its tactile affordances, such the feel of the vibrational heartbeat and its softness, that appeared to aid in down-regulating: "I think focusing on those things [textures and sensory feelings] about the toy is like really helpful for me, noticing the changes in the heartbeat, and the purring sound" (U13). Furthermore, most of our participants also described how the impact of engaging with Purrble's embodied emotion regulation process had noticeable physiological effects on them. For instance, several participants shared that they could feel their heart rate slow after using the smart toy: "you can feel like your heart's sort of like gone quieter and more paced, so I think it's slightly physical" (A8).

However, we found that this entrainment was not seen as a silver bullet that could be applicable at any time, as for a few participants it prompted unwanted effects in specific situations. For example, some reflected that they did not see much benefit in using their Purrble when they were already calm: "I did think it was a bit stressful that it had a stressful heart rate 'cos it was like really fast and I was like really calm and I was like "oh no, I've gotta like slow it down!" (A16). Others shared that, while they did find the interactions useful when stressed, the racing heartbeat could be overwhelming when they felt overly anxious: "my heart rate synchs with his, [...] when it comes back up then my heart starts beating quicker as well" (A26). Nevertheless, most participants seemed to find the optimal threshold for when to interact with the device to maximise its impact—often in mid-point between being too calm or too stressed either before, during or after emotionally overwhelming situations e.g. stress about medical appointments, anxiety due to homework assignments, or when feeling lonely.

4.2.3 Mechanisms to foster repeated engagement. About half of the participants also mentioned that they sometimes would not think to use Purrble in the moments they acknowledge it would be useful, e.g. when feeling stressed or overwhelmed: "Like there'd be days when even though it's right there, I'll forget that I can use it and then I'll be like 'Oh, what am I doing? I could have been doing this the whole time instead of just doing nothing or fidgeting with something else'" (A20).

As a solution, some (about a third) tried to build a habit of using Purrble so that they would then 'automatically' reach out for it in moments of need. For instance, some participants managed to integrate Purrble into their daily work routines, as illustrated by the quote below, or into nighttime routines and use it "pretty much every day when I go to bed" (A12).

"Start with a good kick of motivation before doing something unpleasant. And I think the habit-forming part for this is quite nice because it's, you know, it's always kind of the same sensory experience and then you move on to work and I think that's a nice way to get sort of going; have, for instance, a little pre-work routine." (U7)

For others, the mere presence of the tangible device served as a physical reminder to 'check on their emotions' and practise 'self-care'. As such, most participants shared that they liked to keep it in sight so that they would remember to use it when needed, e.g. on the bed for those who used it to aid with sleep or loneliness, or by the desk for those who mostly used it to help with work-related situations.

4.3 Meaningful Strategies that Emerged Around the Interactive Tangible Device

Beyond the general engagement patterns described above, those participants who found Purrble beneficial reported engaging in meaningful ways, and several strategies that we did not expect emerged naturally from such repeated interactions. In this section, we describe the three main themes that emerged from the interviews: (i) Purrble as a tangible attentional anchor to facilitate the practise of cognitive strategies; (ii) using the interactive tangible device as an emotional companion that fosters self-compassion; and (iii) a broader discussion of how the effects that emerged from interacting with the device fit into youth's daily lives and were used as a mitigation, prevention and intermediary strategies.

4.3.1 Tangible Anchor to Facilitate Cognitive Strategies. As previously mentioned, on a cognitive level, participants described how focusing on soothing Purrble served as a distraction from negative emotional triggers, which in turn stopped them from "overthinking that thing in your head" (A12) and allowed the negative emotions to subside: "quiets the mind" (A11). In all cases, it was shifting their attention to an external and "more concrete" (A13) object that appeared to be easier for youth, compared to using cognitive techniques which required substantial cognitive effort and focus: "I've always had a hard time meditating, you know, just staying and not thinking about anything, and Purrble helps me do that. It is like a token to help me meditate, which I find helpful to regenerate and reduce anxiety levels" (U9).

While other techniques or activities youth would typically use to regulate their emotions had similar effects (e.g. meditation, grounding exercises, going for a run, or playing videogames), participants felt more in control with Purrble: "I'd say because you're a bit more in control of it, I think that helps because it's more interactive" (A7). A few participants also mentioned how they would have liked receiving additional "advice" or readings such as "research articles" "explaining what other solutions are there to reduce anxiety levels and how to use Purrble in combination with other strategies" (U9). Furthermore, for some participants, it seemed to have replaced maladaptive emotion regulation strategies such as using their phones as a meaningless distraction: "I used to watch YouTube videos to fall asleep to. So yeah, it has replaced that. I just turn my phone off now." (A12) or waiting for negative intrusive thoughts to pass "I tend to suffer from quite dark intrusive thoughts so they become a lot stronger during this period of time [waiting the situation out], whereas having Pablo [Purrble] stopped me from getting to that stage" (A3). Thus, the advantages over other cognitive techniques appeared to stem largely from it being a physical object embodying the process of regulating emotions: "having that physically panicking little thing, I found it helpful both as a reminder and also in the process" (U7).

4.3.2 Compassionate Emotional Companion. Interestingly, we also found that in many cases Purrble became an 'emotional companion' with whom to navigate difficult moments. As such, interacting with Purrble appeared to resemble the benefits of socially regulating others' emotions. And was generally proven beneficial both for those struggling with academic-related stress:

"I know he is not real — but the Purrble's also feeling stressed and there's a bit of mutual problem. [...] it's like if you're struggling on one of your assignments and then you hear your friend is also struggling on that assignment, you feel a bit more comforted to know that other people are also going through that and feeling it. I feel like it's a similar thing." (A16)

as well as for those living mental health conditions:

"I feel quite vulnerable, not like useless, but I guess kind of like needy when I'm anxious or stressed. And I think that it's appealing to me to have something that I can take care of instead. It's really hard to pin down, but it's like it gives me more of a purpose. It's kind of like companionship or understanding, having something that I relate to, I struggle with similar things, and it's comforting being the person who is providing that support." (U17).

In particular, this sense of companionship was also seen as beneficial by those struggling with loneliness: *"It doesn't really talk to you, and it doesn't respond, but it makes you not to feel alone anymore. [...] You have the feeling of having someone around you". (U10)* On top of that, on several occasions participants also described how Purrble also prompted them to have conversations about their emotions with peers—as illustrated in the quote below—, and thus Purrble naturally created peer-support communities: *"It was super nice because it was a way to talk about managing your emotions, [...] a nice way to reach out to someone who wasn't in my immediate friendship circle but also was going through the same kind of experience to me" (U5).*

The 'cute' aspect of the interactive tangible device combined with its softness seemed to encourage nurturing behaviour and language around it. For instance, most participants who found Purrble beneficial referred to it as 'him' or 'her', with several even giving it a name. In fact, the majority of the youth found the comforting tactile interactions similar to the sensation and felt effect of interacting with a pet: *"it feels like having a little pet" (A12).* As a result, most participants detailed how they felt the need to interact with Purrble every time it showed anxious behaviours: *"I get weirdly attached to it and I think it's- When my stepdad turned it upside down I was like 'No, don't do that! That's mean!'. Even though I know it's not real, it still feels kind of very alive. And you have empathy and emotions towards it, even though you know it isn't real" (A7).*

In turn, these ongoing nurturing engagements encouraged youth to adopt an attitude of self-compassion, rather than judgement, in moments they were feeling stressed or anxious, as illustrated by this participant:

"When you're struggling to look after yourself, the act of looking after something else is really helpful [...] Because you kind of have to treat this with kindness, if you're not treating yourself with kindness it kind of helps you to re-learn how to be gentle with yourself and forgiving." (A29)

Lastly, youth also described experiencing an increased sense of agency and control since having Purrble, as they felt more capable of managing their emotions without the need of immediately seeking support in friends or family: *"I don't have to wait or message a friend and I'm not waiting for her to reply to make me feel better. As soon as I feel it, I'd go and get it, and it's right there and it's an immediate help and release for the emotions" (A27).* This appeared to stem both from their improved mood once they had calmed down, as well as the sense of achievement soothing Purrble gave them: *"you stroke your cat and it purrs, and it gives you that sense of satisfaction that you are making your cat happy, and I think Purrble gives you that experience as well" (U5).*

4.3.3 Mitigation, prevention and intermediary strategies. Most of our participants reported using the interactive device as a mitigation strategy, to support down-regulating in moments of heightened emotions. They shared how, as a result,

they felt better able to resume other activities, such as academic work, while interacting with Purrble: “*having that [Purrble] to focus on, that’s helped continue it [working], and has helped me get things done*” (A2). While some enjoyed going through the full interaction cycle of soothing Purrble, several participants mentioned that for them just “*even having him sat with me on the desk*” (U13) was the right amount of support they needed to have while doing other tasks: “*I kind of end up going elsewhere and trying to do something which also is frustrating because that means I am stopping doing the work to go calm down [...] with Percy [Purrble], I would be continuing doing it but calming myself down*” (A17). In other cases, Purrble also facilitated the practice of cognitive mental health strategies: “*in terms of the strategies that I use such as DBT [Dialectical Behaviour Therapy] stuff, I wouldn’t say it’s replaced it, I would say it’s like enhanced it and made it better*” (A28); that they would otherwise find challenging to practice, as illustrated by the quote below.

“I was under CAMHS⁷ for quite a long time, so I had all the sort of breathing techniques, grounding techniques, the five senses sorts of methods. I’ve got all of those which I tend to try anyways. But then, if none of the more discreet ways are helping or the ways I can just sort of manage it on my own, that’s when I sort of ‘Okay. Now I’ll bring out Purrble and see if it works’. [...] It’s more difficult for your mind to wander off to something else and back to a panic when you got this thing in your hand, and the heartbeat reminds you it’s there.” (A3)

Additionally, some participants also used Purrble as prevention and intermediary strategies, although these were not as prevalent. Regarding the former, several participants described how they found it beneficial to engage with the device for a couple of minutes before a situation they anticipated would be stress or anxiety-inducing. As per the latter, several participants who disclosed living with mental health conditions seemed to find Purrble particularly helpful as an intermediate step to down-regulate after experiencing extreme emotions and before being able to practise more cognitively demanding strategies, as illustrated by the quote above, or to “*put that emotion on hold for a little bit*” (A6).

5 IDENTIFYING OPPORTUNITIES FOR SITUATED AND EMBODIED SUPPORT FOR YOUTH’S MENTAL HEALTH

In this section, we report on the co-design workshops exploring how situated and embodied support could be designed for youth, using Purrble as a proof-of-concept exercise. We draw from the deployment findings reported in Section 4, as well as from the expertise of the youth who had the exemplar tangible interactive device for about 2 months, to gain a better understanding of what Purrble might look if it had been designed for youth—and not younger children. In turn, this helped us think more broadly how to design and optimise situated interventions using tangible devices for this population, beyond Purrble.

We start by providing a general overview of the workshops, followed by unpacking the main challenges as identified by the additional resources that were brought up by the youth: both *for* and *beyond* the direct use of the interactive tangible device. During the workshops, and using Purrble as a proof of concept, we aimed to scope the discussions around the experiences that such interactive tangible devices could afford to support youth’s mental health, rather than on the actual form and aesthetics of the device itself.

5.1 Suggestions Around the Interactive Tangible Device

While all participants who joined the workshops said that they found Purrble beneficial and would recommend it to other people their age, they also discussed potential changes they would like for such an interactive tangible device to

⁷<https://www.nhs.uk/mental-health/nhs-voluntary-charity-services/nhs-services/children-young-people-mental-health-services-cypmhs/>

better fit their needs. As such, in this section, we provide an overview of key aspects youth valued from the current design—and would like to maintain—, and the main challenges they would like to address.

5.1.1 Identified Key Beneficial Aspects. In the workshops, we identified several aspects of Purrble that youth found to be notably beneficial as a means to provide mental health support for people their age. An aspect that all youth in our workshops valued, and that was particularly important for those who disclosed living with mental health conditions, was how regular engagement with the interactive tangible device promoted empowerment and a *sense of agency* over their mental health. Moreover, youth also appreciated that the intervention was *theory-driven* and research-backed, although in the case of Purrble the research was done with another population. In this regard, most participants discussed how they would like to know more about the underpinnings of why and how such an intervention could work for them, as well as evidence of it working for others e.g. in the form of testimonials. Finally, another common thread in the workshops centred around the balance between *ambiguity* and *discoverability* offered by the interactive tangible device. The majority of participants found that the embodied metaphors used were easy to understand and facilitated repeated interactions from the initial introduction to Purrble, yet they were also ambiguous enough to allow youth to build their own narrative around them. To this end, the most common words used by participants to describe how they perceived such situated and embodied support were 'inviting' and 'suggesting', as opposed to other approaches they had experienced in the past that they found too 'patronising' or 'dictating' in their prior experiences with mental health care.

5.1.2 Augmenting Current Interactions. Our participants also identified potentially interesting design opportunities to expand the current capabilities of the interactive tangible device. A prevalent discussion on this topic was around the degree of simplicity—or specialisation—of the embodied interactions afforded by such devices. In particular, three interrelated aspects emerged from the workshops: simplicity as a quality to provide consistent assistance, additional sensory features as additional delivery mechanisms of situated and embodied support, and specialised support tailored to specific cognitive strategies.

Most participants found the predictability and simplicity of the interactions to be reassuring: they knew what the outcome was always going to be, and it was easy to successfully accomplish the task. While youth mostly found the current embodied support comforting, grounding and easy to engage with, there was an overall interest in adding a layer of complexity by having access to different types of support—rather than only being able to engage with a single interaction loop. For instance, a common suggestion was providing different settings tailored to specific situations e.g. an only-purring setting for sleep or a silent setting to be taken discreetly to public spaces such as the library. Another example that was brought up in most workshops was providing bespoke support for the practice of different—more cognitively challenging—strategies, such as to scaffold mindfulness exercises by fostering the synchronisation of the breath with Purrble's feedback, or facilitating CBT-based activities by externalising their emotions onto the tangible device.

5.2 Additional Support Beyond the Interactive Tangible Device

Most participants also saw value in having access to additional support, beyond that provided by the interactive device, as a means to scaffold the transfer of skills, access a peer-support community, and uphold meaningful and habitual use. In every workshop session, participants emphasised that they saw these as additional layers of support expanding the situated and embodied support from the interactive tangible device. Therefore, these should not be seen as exclusive

but as complementary. In this vein, youth shared that they would like these to be presented as optional features from which they could pick and choose what resources to engage with at different times, depending on their needs and goals.

5.2.1 To scaffold the transfer of skills. In most workshops, participants placed particular emphasis on supporting the transfer of skills beyond the direct use of the interactive tangible device. Throughout the deployments, we found that youth's use of Purrble was perceived as an intimate practice that would happen mainly at home, in their bedrooms, and they would hardly ever take it elsewhere. Nevertheless, during the workshops, many participants wondered about how the strategies and benefits of using Purrble could be applied to other—less private—situations. For instance, when feeling stressed during an in-person seminar at university or socially anxious in a train full of people.

Therefore, in almost every workshop, there were ongoing discussions around the different ways in which the interactive tangible device could be extended in more discreet forms. Some youth thought that having an app would allow them to have ongoing access to the situated support as it was already part of their everyday lives, whereas others feared that the perceived effects and engagement patterns would change as the technological device was also the main stressor (e.g. having access to social media and emails from work). Another common suggestion was that of having an additional, smaller but still soft, tangible token that would provide embodied support in moments of need, although some feared they would forget to take it with them regularly or even lose it. Interestingly, regardless of the form this extended support would take, all participants emphasised how it would be essential that it recreated the original pet-like & care-taking interactions as these were key to fostering self-compassion and emotional companionship.

5.2.2 To access a peer-support community. According to our participants, another tier of additional support would be having access to a peer-support community. Importantly, youth thought it would make the experience of navigating mental health challenges less lonely and could be a supportive and motivating feature. This resonates with the concept of Purrble as an emotional companion that we found in the deployments and how it prompted the creation of communities for emotional support e.g. within their households or with peers (c.f. Section 4.3.2). Most participants saw beneficial opportunities in being able to connect with peers to share ideas and experiences, that would ideally inspire new contexts or strategies for using the device. Furthermore, several participants mentioned including professional support in these peer-communities, as a low-key way of accessing more science-backed information rather than just suggestions from peers.

While for many, the layer of anonymity that online interactions can provide was seen as an opportunity to overcome stigma and to seek other's help, others also expressed their concerns about privacy and the potential risks of harmful or hurtful interactions. As a potential solution, several participants suggested the concept of semi-anonymity by having the Purrbles 'sign up' to the community rather than youth themselves: the person's name would not be disclosed yet the account could be monitored and traced if necessary.

5.2.3 To uphold meaningful and habitual use. Another common discussion thread during the workshops was around how to support youth in creating beneficial habits for their mental health, and in particular how such behaviour change could be enabled by an interactive tangible device such as Purrble. As mentioned above (cf. Section 4.2), many workshop participants described how it was in the moments of greatest need that they sometimes forgot to practise beneficial strategies. To address this, several youth saw value in having reminders around the tangible device, such as kind and gentle notifications on their phones. Again, youth emphasised how these nudges should be framed in a positive way and be inviting rather than dictating, to support them in creating a space and time for using Purrble.

Many participants also saw value in having the option of joining a more structured action plan to learn how to use the tool, often compared to the Headspace app to start with meditation. Building on the emerging impact we saw during the deployments, in almost all the sessions it was discussed how youth would like to have access to information to learn how to use the tool more purposefully. For example, as an aid to practise other cognitive strategies, or to uphold regular compassionate self-care. In the few workshops that included youth who disclosed living with mental health conditions, participants discussed the opportunities of such an interactive tangible device to harness professional mental health support. If designed correctly—always described as not in a 'dictating' and 'patronising' way—youth found this to be a particularly valuable approach as an 'in' to access other evidence-based approaches, that can normally be intimidating and hard to access.

6 DISCUSSION

In this paper, we explored the use of an interactive tangible device to support emotion regulation practices for youth. Our findings from the two 1.5 month deployments with adolescents and university students indicate that, for most participants, the interactive tangible device offered accessible in-the-moment support that helped them cope with emotionally difficult situations. In addition, we found that these soothing and grounding effects seemed to emerge from the physical qualities and tactile affordances of the technology-enabled object. Then, in the co-design workshops with youth, we aimed to understand how we could design technology-enabled solutions for youth's mental health that empowered them with constructive coping strategies.

In this section, we address the original research questions and discuss how the findings from this study are opening up the design space of situated and embodied support in interesting ways, with potential opportunities for designing interactive tangible objects for youth's mental health.

6.1 Differences in Appropriation: a Toy for Children, a Tool for Youth

The data from the study reported in this paper provide preliminary support for the acceptability and benefits of interactive tangible objects, such as Purrble, for youth's mental health. This is interesting, given that Purrble had originally been designed for a younger population: to deliver in-the-moment support (situated), and to empower children to learn how to regulate their emotions without the need for any formal training required for the child or their adults (child-led). A key difference, however, is how the device has been picked up differently by these populations. In contrast to the data from previous deployments with children [98] whereby Purrble was talked about and interacted with as a smart toy who needed *help from them*, we found that youth appropriated the device as a tool for their mental health *to help them*.

Similarly, while the children's use was often motivated by a sense of responsibility to soothe the toy, youth primarily initiated interactions as and when they needed to down-regulate themselves. This difference appears to be, in part, due to the different framing of Purrble for each age group: the framing of the toy that children readily accepted was that of an 'anxious creature in need of assistance'; in contrast, youth seemed well-aware of the reasons they were using the device, and thus, did not need the 'anxious creature' narrative to drive their interactions with it. Nevertheless, this playful narrative seems to have facilitated the creation of a pet-like bond with Purrble [42, 84], encouraging nurturing and compassionate behaviours similar to those found in human-animal interactions [7, 36, 57]. Beyond designing for children, playfulness is being explored as a design resource for mental wellbeing as it has been shown that it can provide emotional support for adults [4, 19, 38, 103]. As such, we argue that play can be an interesting approach to consider when designing situated and embodied support for youth's mental health e.g. to foster self-compassion.

Finally, the commercial units deployed with youth did not have the capacity to log interactions as was the case with the research prototypes previously deployed with children [55, 98]. Nonetheless, the qualitative data appear to suggest that most of the youth included in this study interacted with the toy less frequently than children in previous studies did. This might indicate that while youth primarily used the device more purposefully, as a tool to be used in specific situations, children would also engage with the toy in play, as expected given the importance of play in childhood [51]. Another plausible explanation, which is also in line with the study's findings, is that the longer length of the deployments with youth (1.5 months vs. 3-7 days with children) might have allowed for the practices around the interactive tangible device to stabilise more after the first weeks of deployment, when they already knew how the device worked and in which situations it was useful—mostly in moments when they needed support to cope with emotionally difficult situations. In this regard, the physicality and tactile affordances of the exemplar device seem to have been the delivery mechanism through which the effects emerged. Recent work in HCI has explored the use of haptic feedback and embodied metaphors to scaffold the regulation of attention or affect using on-body interfaces [24, 70, 82, 88, 105]. In addition, the use of technology-enabled objects have also been explored as ambient displays to promote behavioural change, healthy habits and self-reflection [50, 56, 73, 92]. Based on our findings, we argue that interactive tangible objects can bridge these two design spaces by offering novel opportunities to provide situated assistance in moments of need in two ways: via direct interaction to aid with down-regulation and, beyond that, as an ambient interface that serves as a gentle reminder and can nudge the person to practise self-care.

6.2 Design Considerations

The design considerations outlined below emerge from our attempt to reflect on particular characteristics of Purrble that youth seemed to value, and abstract them into broader designing implications for technology-enabled interventions for integrating interactive tangible devices in interventions for youth's mental health. An interesting aspect about the physicality of Purrble and the particular mode of interaction it affords is that it interactively scaffolds the user's experience and nudges them towards a particular emotional trajectory, often seemingly without requiring substantial cognitive focus once the interaction has started. One way of thinking about such design effects of the embodied nature of the tangible device is through the lens of Somaesthetic design [46] and Experience trajectories [10, 101]. Specifically, we propose that modalities which allow for a felt, subtle, inward-looking experience could be particularly useful in this application space: it is the object's physical presence in the user's environment and the mode of interaction that seems to enable people to establish a different emotional trajectory which would be otherwise unavailable to them. For example, in the case of traditional emotion regulation skills building (e.g., [35, 69, 89]), the usual approach for an individual who experiences negative emotions would be to notice that they are getting stressed (emotion awareness), choose one of the techniques they have been taught to self-regulate (e.g., cognitive reappraisal), and then carry out the technique by applying the general approach to the specific situation. All these steps were then assumed to be successfully accomplished without any external scaffolding beyond what they themselves can do: requiring the person to effortfully 'use your mind to soothe your mind', as mentioned by some of our participants. In contrast, the physicality and haptic feedback appear to turn an experience that is normally cognitive and effortful—such as emotion regulation—into something embodied and naturally grounded.

What was particularly interesting in this study was how participants contrasted the ease with which they derived support from the tangible device with the effortful engagement that more cognitive or body-based techniques required, especially in the moments they were stressed or overwhelmed. If it is indeed the vibro-tactile pattern that gently guides the interaction and, through this, the users' emotional state, the next question is whether a more purposeful design of

haptic experiences is possible, to support distinct emotional trajectories (e.g. in-situ support during stressful events, to facilitate winding down, or to benefit restful sleeping); as well as questions about the consistency of the effects across user groups (e.g., the high heartbeat perceived as stressful for some youth, but not for children). A better understanding of the underlying design space (see, e.g., Haptipedia [94] for a related body of work) would enable embedding these tactile trajectories into other form-factors. For example, one could consider a hybrid approach between SARs [59] and digital companions [104], as one potential solution to the peer pressure dilemma our participants mentioned. We speculate that designing a more discrete soft and fluffy tangible (e.g. a case for the smartphone that is then actuated by the phone itself) could mediate the tactile trajectories of the intervention similarly to Purrrble, and enable linking with traditional digital technologies already present in youth's everyday lives such as smartphone app could bring additional depth to the experience. Moreover, we argue that this could also allow embedding additional resources that our participants found valuable, such as having access to an online peer-community to promote a sense of belonging and facilitate self-disclosure [28, 83]. If successful, such a design would turn potentially stigmatising and externally observable 'smart toy use' into 'smartphone use', which is well normalised in a social context for youth.

Finally, it is an open question as to the extent that interventions such as an interactive tangible devices—such as Purrrble or the phone case envisioned above—could serve as complements to existing mental health interventions, explicitly scaffolding the transfer of taught skills from sessions into daily life. Currently, existing interventions predominantly teach skills in sessions, with the expectation that the individual has to then consistently practice these as 'homework' in between therapy visits. Consequently, patient adherence to treatment and home practice recommendations constitute crucial intermediate outcomes impacting treatment effectiveness [1, 39, 44]. Our findings point to the potential of physical objects and embodied interaction to complement existing mental health provision, by enabling situated practice and skills application in the moments the users perceive as challenging (e.g., the tangible device supporting the user to down-regulate anxiety in the context of emotion regulation or to practise cognitively demanding strategies).

7 CONCLUSIONS

Developing adaptive emotion regulation strategies has been proven to be an important factor in maintaining a good mental health across the lifespan, but particularly during youth. While prior work in HCI and Psychology has investigated the design and implementation of mental health technologies for youth, it is still unclear what delivery mechanisms can help them cope with emotionally difficult situations in-the-moment. In this paper, we explored the appropriation, engagement models and perceived effects of an interactive tangible device designed to support emotion regulation practices for children when deployed with youth. The qualitative data from the two 1.5 month deployments with adolescents and university students indicate that, for most participants, the interactive tangible device offered accessible in-the-moment support that helped them cope with emotionally difficult situations. Also, ongoing engagement patterns emerged naturally, mostly driven by the soothing and grounding embodied interactions. Then, by involving youth in co-design work, we have attempted to understand how we could design technology-enabled solutions for youth's mental health that provide situated and embodied support while empowering them with constructive coping strategies. Our findings suggest that the physicality and tactile affordances of interactive tangible devices could serve as an innovative delivery mechanism to provide embodied and situated support in mental health interventions for youth. We end with a discussion of the observed themes and abstract them into broader design considerations in this space, such as using such devices as a potential bridge between the physical and cognitive strategies that are commonly used for emotion regulation.

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