



# Flipping Perspectives: Visualising Digital Smell Training

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## ABSTRACT

Recovering a lost ability is rarely easy, but unlike strengthening a muscle, progress in *smell training*, repeated exposure to specific scents to support recovery or maintain function, is often invisible. For those undergoing Digital Smell Training (DST), data visualisations may be the only markers of change. *But how can graphs and numbers sustain motivation over months of slow, unpredictable recovery?* This pictorial adopts a Research through Design approach to explore how data visualisations might better support motivation, adherence, and long-term engagement in DST. We draw on a six-month in-home study with 18 participants with varying olfactory abilities using a technology probe. Following initial feedback, we ran a co-design workshop to understand participants' visualisation needs. These insights informed eight design directions and three visualisation concepts, later evaluated in a focus group. We explore how visualisations help '*flip perspectives*', from tracking outcomes to nurturing perseverance across the uncertain journey of smell rehabilitation.

CCS Concepts: • Human-centered computing - visualisation design and evaluation methods.

Authors Keywords: Smell, Olfaction, Smell training, Data visualisation, Digital health data

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# 1 INTRODUCTION

**Imagine trying to recover a lost ability, whether it's regaining mobility after an injury or retraining a lost sense. The journey can feel isolating and slow, but you have to show up to get that ability back. For individuals undergoing smell training, the challenge is compounded by the absence of tangible feedback: progress is not as easily observed as a healing wound or a strengthening muscle. Instead, recovery is often measured through data displayed on a screen - graphs and numbers that may fail to capture the subtle, incremental improvements. For many with smell loss, this is a daily reality, impacting their motivation to continue their rehabilitation journey.**

The six-month field study was conducted in the UK with 18 participants, who had varying levels of olfactory function. Participants were divided into two groups: those aged 65-75 with no or mild smell disorders, who may benefit from training to counteract sensory decline [32], and those aged 45-55 with smell disorders, who may benefit from regular training for rehabilitation [28]. While the study did not specifically collect detailed cultural background data, participants identified as British nationals, with one also holding French nationality. Ethical approval was granted by the local university ethics committee.

Loss of smell affects 22% [10] of the general population in Western countries, rising to 60% among smokers [2] and 75% in older adults [24]. Despite its negative impact on health and quality of life [22], smell loss remains under-addressed [4, 27]. Smell training [16], which involves regular exposure to selected scents, has been shown to support recovery and wellbeing [28]. However, the slow and often unpredictable nature of recovery makes it difficult for users to stay motivated and adhere to the twice-daily training routine [12].

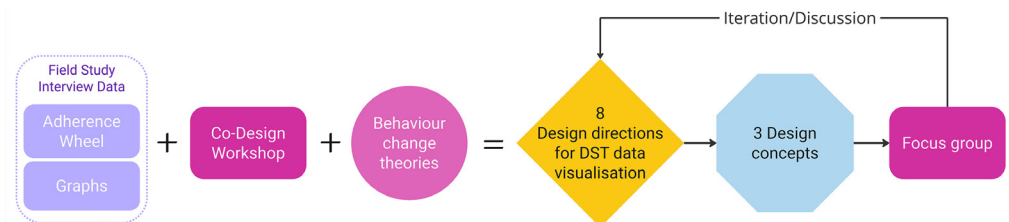
Adherence, engagement, and user experience in real-world settings remain poorly understood [12, 26, 28]. At the same time, traditional methods often lack precision in scent delivery and provide limited tools for tracking adherence and changes in perception. Digital Smell Training (DST) solutions offer more control and insight through scent-delivery devices and companion apps [5]. Still, a key design question persists: how can the design of these digital solutions, specifically data visualisations, foster motivation and sustain adherence throughout the often nonlinear recovery process? The challenge becomes even greater when recovery can span up to two years [28], emphasising the need for tools that 'flip perspectives', that encourage perseverance rather than focusing on immediate results.

This pictorial adopts a Research through Design (RtD) approach [13] to explore how data visualisations within DST can enhance user motivation and adherence, using the design process not only to create practical solutions but also to generate new insights and knowledge [37]. It draws on the first in-home qualitative study of DST: a six-month deployment with 18 UK participants aged 45-75 with varying olfactory abilities. This work engages an underexplored demographic in HCI and introduces a novel context for both longitudinal technology deployment [20] and smell research centred on user experience rather than clinical outcomes.

We deployed a technology probe [17], a flexible, open-ended approach used to understand user needs, identify engagement barriers, and spark new design ideas. The probe included a digitally controlled scent delivery device, a companion app for tracking progress, a training journal, and a paper-based 'adherence wheel' designed to encourage routine and reflection. This paper focuses on the role of data visualisation within this overarching project that explored user engagement with DST.

Our exploration of data visualisation began with participant feedback on in-app graphs and printed monthly summaries. This feedback highlighted the motivational potential of visualisations and prompted us to investigate more engaging ways of presenting data. We ran a co-design workshop to better understand participants' visualisation needs and preferences. Drawing on these insights, alongside Self-Determination Theory (SDT) [30] and the Motivation and Behaviour Change Techniques (MBCT) framework [34], we developed eight design directions that bridge theory and practice [31]. These informed a set of conceptual visualisations, later refined into three concepts and evaluated in a follow-up focus group.

Our findings highlight that effective DST data visualisations must go beyond tracking progress; they should foster long-term engagement by adapting to users' evolving needs and preferences. This addresses a broader challenge in healthcare design, where clinical recommendations often misalign with lived experience [7]. Rather than relying on users to persist despite slow progress, we can design visualisations that reflect the gradual nature of recovery, celebrate small wins, and maintain motivation. While rooted in DST, this pictorial offers insights for other health interventions [3, 21] requiring long-term engagement across uncertain trajectories.





## 2 PREPARING FOR THE DEPLOYMENT

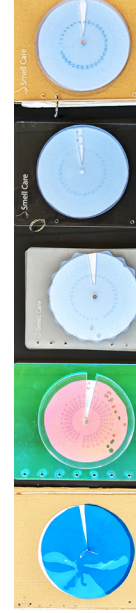
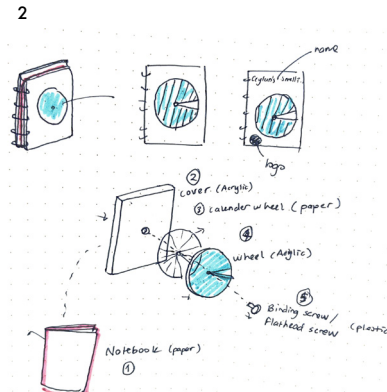
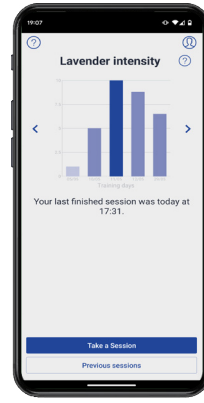
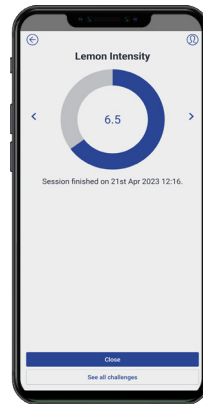
To explore how participants engaged with DST in their daily lives, we designed a tech probe [17] that included a digitally controlled scent delivery device (Figure 1) and companion app (Figure 2), along with an adherence wheel (Figure 3) and training journal. Participants were asked to complete two training sessions per day. Each session lasted about five minutes and involved 12 scent deliveries (two randomised repetitions of six scents), followed by intensity ratings recorded on a 0-10 scale via the app.

The app provided immediate feedback after each session, including bar charts summarising recent data and doughnut charts visualising average intensity ratings per scent (Figure 4). While useful for tracking short-term changes, these visualisations offered limited support for understanding long-term progress, which is a key factor in maintaining motivation and adherence. To address this, we developed a set of additional visualisations aimed at making longer-term patterns more visible and personally meaningful. These included:

- Monthly adherence percentages (e.g., 84% adherence in month one).
- Weekly and monthly adherence line graphs.
- Line graphs tracking average perceived intensity ratings per scent over time.
- Scent-specific intensity data reflecting individual differences.
- Change-bar graphs illustrating intensity evolution and participant preferences for monthly scent variation.

These visualisations were printed and shared during monthly in-person meetings, where the researcher guided participants through the graphs and invited reflection on their training experience. To further support motivation and consistency, we introduced two additional components: a training journal and a custom-designed adherence wheel. Integrated into the tech probe, these tools aimed to extend beyond digital feedback, offering tactile and visual ways for participants to track progress and reflect on their routine.

The following section explores the development and use of these tools in more detail, focusing on how they supported participants' motivation and shaped their engagement with the training process.



## 2.1 ADHERENCE WHEEL

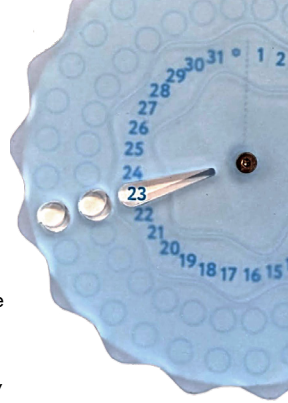
High dropout rates in smell training, often tied to a lack of perceived progress [12], underscore the need for designs that prioritise fostering commitment over focusing solely on results. To address this, we developed the adherence wheel which is a tangible, visually rewarding tool designed to track progress and promote long-term consistency.

The adherence wheel, modeled on a circular calendar, displays days numbered 1 to 30 (or 31), with two small holes per day representing the two daily sessions. Users fill in these holes after completing a session, fostering a sense of accomplishment and making progress tangible. Unlike linear or streak-based designs, the circular format de-emphasises specific dates, focusing instead on cumulative progress [19]. This approach avoids demotivating users who miss sessions, encouraging persistence rather than perfection [7]. During monthly visits, the researcher replaced the wheel with a blank one, reinforcing the cycle of reflection and renewal.

Before finalising this design, we explored alternatives inspired by RGB overlays and steganography, which revealed parts of an image after each session. These concepts symbolised how each session contributed to the bigger picture, drawing from themes like “unlocking the wonders of smell” and “the hidden sense.”

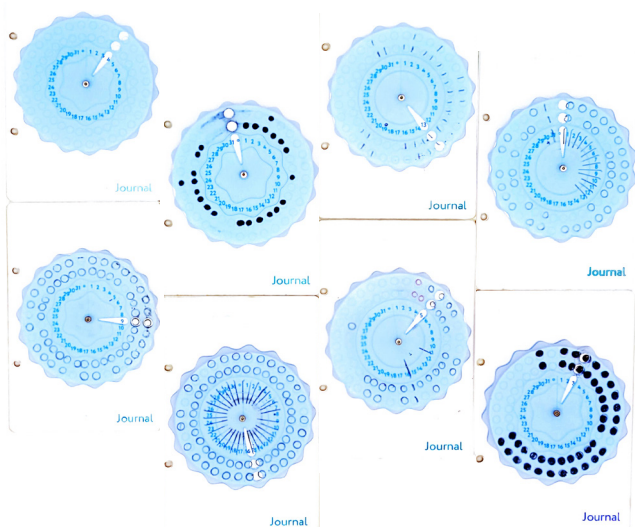
While we initially considered integrating the wheel with the scent delivery device for a seamless experience, this proved cumbersome and disrupted the design's simplicity. Instead, the wheel was embedded into the cover of a training journal, which participants used to reflect on their progress. This unified approach streamlined the interaction, avoiding overload from multiple tools. The wheels' calendar insert was replaced each month during researcher visits, providing participants with a fresh, blank one to continue tracking their progress.

Following paper prototypes (Figure 3), we crafted the wheel from blue acrylic to align with the project's aesthetic. Although the steganography- RGB effect was less pronounced, the frosted acrylic and ridges added a tactile quality, making the wheel both satisfying to handle and easy to use.



# 3 REACTIONS FROM THE FIELD

This section presents insights from qualitative interviews conducted with participants during the six-month field study. It focuses on how participants engaged with two key components: the adherence wheel and the monthly data visualisations. Thematic analysis [23] was used to analyze the interview data. We began with high-level deductive codes based on interview questions related to engagement with the adherence wheel and participants' perceptions of the visualisations. As the analysis progressed, inductive codes were generated, which were organised in a time-ordered matrix [15] to track evolving themes.



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## 3.1 REACTIONS TO THE ADHERENCE WHEEL

Thirteen out of seventeen participants engaged with the adherence wheel, an optional tool available throughout the six-month DST study (Figure 4 shows examples filled out by different participants). Reactions were mixed, reflecting varying levels of engagement and perceived usefulness.

**Visual Reminder and Motivation:** For many participants, the adherence wheel acted as a helpful visual cue, enabling them to track progress and easily identify missed sessions. This visual feedback served as a reminder, motivating consistent training. However, some participants occasionally forgot to use the wheel, especially when their training journal was left open, obscuring the wheel's display.

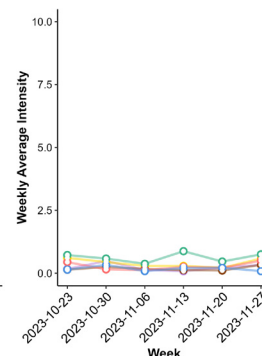
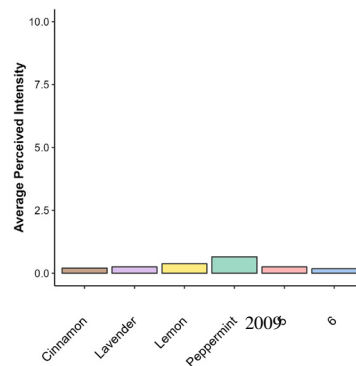
**Sense of Accomplishment:** Seeing the wheel filled at the end of the month provided a sense of achievement for several participants. The act of physically marking their adherence on the wheel contributed to a feeling of accomplishment and motivated them to continue with their training. One participant [P05, Month 6] explained that filling in the session on the wheel helped them build a habit by encouraging them to stick to a regular smell training routine. The wheel also allowed for varying training frequencies and durations, showing that progress could still be made (i.e., non-streak-based circular approach), even with missed sessions or inconsistent routines. This resonated with participants who found the visual representation motivating and encouraging, even when their engagement didn't align with idealised expectations.

"... I just really forgot about it because I have the book (i.e., journal) open and then when I use it I turn the pages so I don't really close it." [P3, Month 3]

"It allows me to quickly see when I haven't done one." [P11, Month 2]

"It helps to tie you down to a routine of doing it regularly." [P05, Month 6]

smell\_number  
Lavender  
Lemon  
Cinnamon  
Peppermint  
5  
6



## 3.2 REACTIONS TO THE MONTHLY GRAPHS

Most participants initially reported limited changes in their perception levels, with significant progress only becoming evident later. This slow progress, reflected in the monthly graphs, often made it harder to stay motivated.

Reactions to the monthly perception graphs were mixed. Some found them validating and motivating, while others raised concerns or suggested improvements.

**Confirmation and Validation:** Many participants felt the monthly graphs validated their subjective perception of progress. Seeing positive trends reassured them and reinforced their self-assessments.

**Motivation and Interest:** For some participants, the perception graphs served as a source of motivation, especially when they showed positive trends. The visualisations also prompted reflection on their experiences, helping them connect their perceived progress with events or circumstances in their lives.

**Interpretation Difficulties and Demotivation:** Not all participants found the graphs easy to interpret. Fluctuations in perception data were a source of confusion and frustration for some. One participant [P2, Month 2] suggested using a smaller scale (e.g., up to five) to better highlight subtle changes in progress. They expressed that this adjustment would make the graph more effective in capturing and validating minor improvements, especially during the early stages of training.

The potential for demotivation was also evident, particularly when participants saw little to no progress reflected in their graphs (Figure 5). One participant [P2, Month 5] expressed a sense of dread and a desire to avoid seeing their percentage in the final month of the study.

**Desire for More Detailed Insights:** Several participants wanted more detailed data, such as exploring correlations between scents or visualising how external factors like weather or mood influenced their smell perception.

"There's almost no point in it going up to ten, certainly at the moment. Maybe in six months' time I might get up to a ten but at the moment you could probably have it on to a five and it would show more, do you know what I mean? Like, the graph?" [P2, Month 2]

"I think it's just reinforcing what I thought anyway... quite pleased that it does because it's not just me thinking... it's there." [P14, Month 2]

"I dread this now. I don't want the percentage this month" [P2, Month 5]



# 4 CO-DESIGN WORKSHOP ON DST DATA VISUALISATION

The co-design workshop, held in the fifth month of the study, aimed to gather feedback on the current data visualisations (app and monthly graphs) and explore future possibilities for DST visualisations. Nine participants, who were already familiar with each other and the project team, took part in the session.

The workshop involved three main activities and lasted around 1.5 hours. First, participants reflected on the app's visualisations, discussing what they liked, disliked, and hoped to improve. They then evaluated the monthly and 3-monthly graphs provided during their visits, considering their usefulness and areas for enhancement. Finally, participants brainstormed and discussed their ideal future for DST data visualisation, envisioning alternative styles and potential data points.

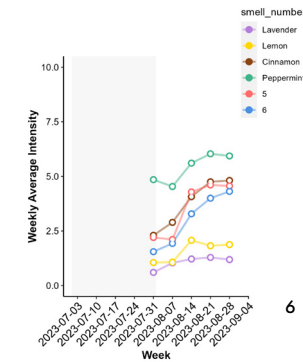
## 4.1 INSIGHTS FROM THE CO-DESIGN WORKSHOP

The workshop participants provided numerous insights on visualising digital smell training data. Adding onto the interview insights, they expressed a strong desire for adaptive, motivational and engaging visualisations that go beyond simple data representation.

**Choice and Flexibility:** Participants highlighted a need for tailored data visualisations to match individual preferences. Some wanted a summary of their overall smelling ability at the end of sessions, rather than a breakdown by scent. Others preferred visualisations that display overall progress, e.g. line graphs, instead of the app's current focus on session-specific bar graphs and doughnut charts.

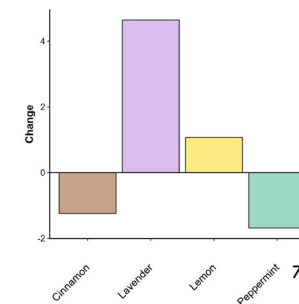
**Motivational Visuals and Feedback:** Participants valued encouraging messages at the end of each session and expressed a desire for even more personalised feedback, such as phrases like "Don't give up, keep going!" or reminders of past successes in perception rating (e.g., Last week you did 6 out of 10 - remember, you can do it again!).

**Beyond Training Data:** Participants showed strong interest in visualisations that go beyond standard numerical training data, proposing features that capture the impact of external factors, such as weather, mood, or other contextual influences on their smell training performance. Additionally, they expressed a desire to include data from smell experiences outside the structured training sessions, noting that these spontaneous interactions with scents were often highly motivating. Being able to log these real-world smelling experiences would provide a fuller picture of their progress and make the digital smell training journey feel more holistic and personally meaningful.



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"It is only relevant when I can smell; otherwise, I ignore the bar charts." (P6)

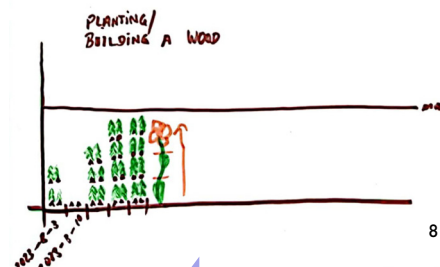
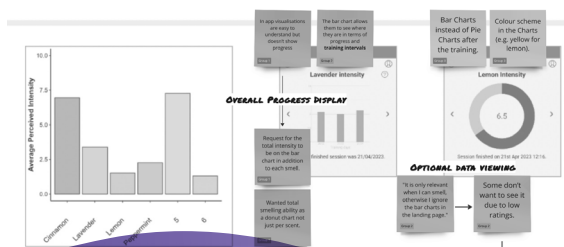


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Participants appreciated the monthly line graphs, but some found the linear or dipping trends demotivating. While some valued the change graphs for highlighting progress, others found them discouraging. Engagement with the visualisations was often linked to perceived progress; many only found them useful when their sense of smell improved, while low ratings led others to avoid reviewing their data.

Overall, participants expressed a desire for optional viewing modes, enabling them to toggle between scent-specific and overall progress views as desired, but also the option to choose to see their data, rather than automatically viewing session data which the DST app currently does.

"I like the change graph; it narrows in on the changes, but it can be demotivating at times (if the change is little or negative)." (P4)



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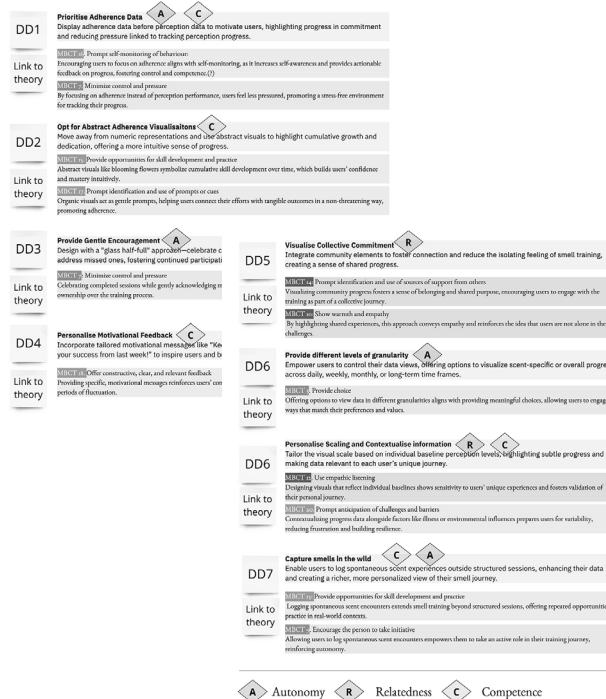
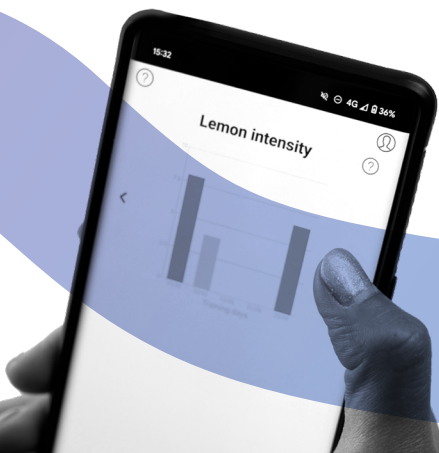
"Smell training can be quite isolating, it would be nice to know that you are not alone - see how others are faring." (P3)

For visualisation styles, there was a preference for non-numerical, positively framed visuals that prioritise motivation over raw data. Suggested examples included "adherence trees" that grow with each completed session or "blooming flowers" that represent adherence, providing fun and abstract representations of progress.

# 5 EIGHT DESIGN DIRECTIONS FOR DST DATA VISUALISATION

This section connects the insights from the field study and workshop with theoretical frameworks to inform the design of data visualisations that can foster motivation and adherence in DST. Motivation, in the context of DST, refers to the driving force behind users' actions and their willingness to engage in the training process. Self-Determination Theory (SDT) [30] provides a useful lens, emphasising three core psychological needs: autonomy (control), competence (capability), and relatedness (connection). Supporting these needs is crucial for enhancing motivation and engagement. The Motivation and Behaviour Change Techniques (MBCT) framework [34] further categorises strategies that can help meet these needs and promote behaviour change.

The first two authors used insights from the field study and workshop to review and develop design directions, which were then evaluated against SDT to refine and expand them. The following subsection outlines 8 design directions, detailing their objectives, strategies for implementation, and connections to both the field study data and relevant theoretical frameworks. The first five directions focus on visualising adherence data, while the remaining three address visualisation strategies for perception data.



## 5.1 ADHERENCE DATA VISUALISATION POINTERS

### DD1: Prioritise Adherence Data

Display adherence data before perception data to motivate users, highlighting progress in commitment and reducing pressure linked to tracking perception progress.

Interviews from the field study revealed that participants often felt apprehensive about viewing perception data, particularly when progress felt slow or fluctuating. Workshop discussions also highlighted that participants preferred engaging with perception data only when they felt positive about their smell perception, rather than after every session. Based on these insights, visualisations should prioritise adherence data, displayed upon session completion and when users open the app. Users can choose to view perception insights as desired, promoting an adherence-first approach that encourages consistent engagement without overwhelming them with performance metrics.

This direction aligns with **competence-supportive** techniques [34] by emphasising small, achievable milestones rather than inconsistent perception data [9]. By focusing on adherence [25], users can focus on their commitment and effort, fostering a sense of achievement and supporting a growth mindset [11].

**DD2: Opt for Abstract Adherence visualisations**  
Move away from numeric representations and use abstract visuals to highlight cumulative growth and dedication, offering a more intuitive sense of progress.

Workshop participants preferred non-numerical, metaphorical visuals, such as blooming flowers or growing trees, symbolising that "every session counts." This organic style provides a fulfilling sense of progress without relying on strict metrics, motivating users by illustrating personal growth. Feedback from the field study's physical adherence wheel also supported this approach, with participants responding positively to the gradual appearance of dots, symbolising their dedication over time.

By avoiding numerical metrics, this approach supports autonomy [9], allowing users to interpret their progress in a self-directed manner. Metaphorical visuals like blooming flowers foster intrinsic motivation, aligning with strategies emphasising **autonomy** through non-pressuring engagement [34]. Such figurative visualisations enable faster, more meaningful self-awareness [29, 35], which can promote self-monitoring and help users meet their goals [14, 34].

### DD3: Provide Gentle Encouragement

Design with a "glass half-full" approach - celebrate completed sessions while gently encouraging users to address missed ones, fostering continued participation without adding stress.

While the adherence wheel downplayed missed sessions, some participants valued seeing unfilled areas as a subtle reminder of skipped sessions. To balance motivation with gentle reminders, the design should focus on completed sessions to celebrate progress, while gently nudging users to address missed ones. Acknowledging that users may skip sessions, adapt treatment plans based on their individual circumstances, or struggle with consistency—behaviours often perceived as 'noncompliant' [7] but actually legitimate attempts to manage their health within their lived realities—can lead to visualisations that celebrate achievements and encourage ongoing adherence. This approach avoids the focus on missed sessions commonly seen in streak-based designs [19] and fosters motivation by highlighting progress, supporting continued engagement, and reducing stress.

This strategy supports **autonomy and competence** [9], emphasising goal-reaching over failure, which can improve resilience [25]. Celebrating achievements boosts users' confidence (competence), while subtle reminders of missed sessions provide structure without external pressure [34].



*Incorporate tailored motivational messages to inspire users and address challenges like perception variability with reassuring feedback to normalise fluctuations and maintain user confidence.*

Additionally, feedback should address perception variability, a challenge noted by participants and also prior literature on smell training [28]. By reassuring users that fluctuations are normal and not failures, feedback can boost confidence and maintain adherence.

## DD5: Visualise Collective Commitment

Workshop participants expressed a desire to see how others were doing, emphasising the importance of connection. To address this, feedback showing community trends in adherence data could remind users that they are part of a larger, supportive group [6]. This collective view fosters motivation by promoting a sense of shared journey, without inducing competition or stress.

Additionally, participants expressed interest in sharing progress with friends and family, highlighting the role of relatedness in enhancing commitment. Presenting community progress in an encouraging, non-competitive way can enhance motivation and well-being.

This direction supports **relatedness**, a core psychological need [9], and aligns with research showing that social support aids behaviour change [1]. Displaying collective progress cultivates a sense of belonging and shared purpose, motivating users without fostering competition [34].

### DD6: Provide different levels of granularity

Workshop participants emphasised the importance of controlling how they view and interact with their data. Allowing users to choose when to view their data - rather than displaying it automatically - helps reduce discouragement from lower ratings. This aligns with the adherence-first approach from Direction 1, enhancing user autonomy by offering customisable, meaningful choices for data visualisation.

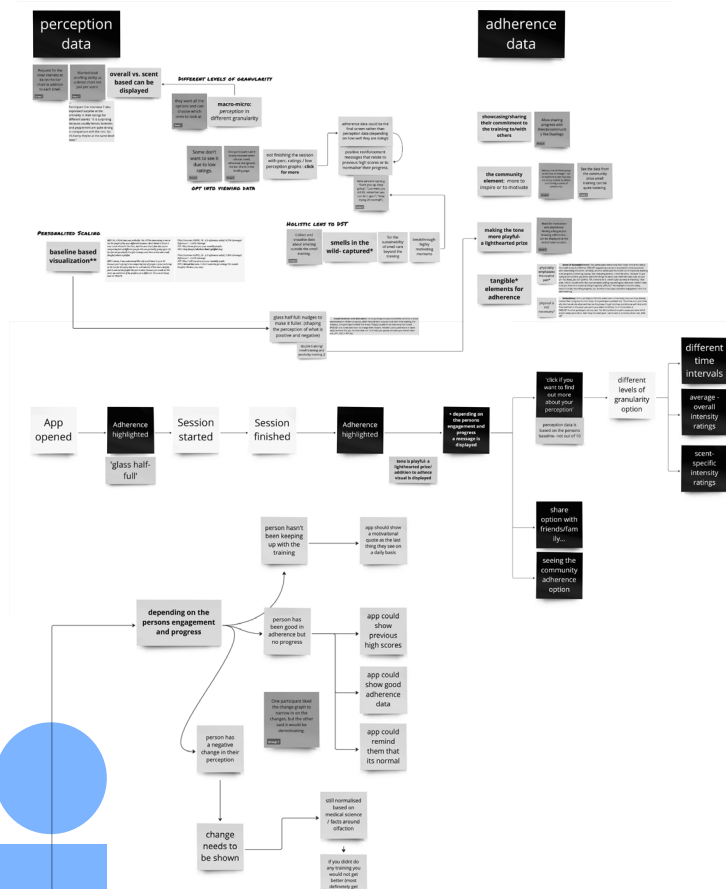
## DD7: Personalise Scaling and Contextualise information

Instead of using a universal scale, this approach personalises progress by using each user's baseline perception levels, allowing for context-sensitive tracking of changes over time. Field study insights emphasised the need for a baseline-centred approach to track shifts in perception without the pressure of external metrics. This method highlights meaningful, individualised progress, motivating users by focusing on their own experiences and goals.

In the interviews, participants highlighted that fluctuations in perception data often caused confusion and led to questions about the effectiveness of the training. To address this, providing contextual information, such as factors influencing smell perception (e.g., illness, medication, environmental factors), can help users better interpret their data, fostering reflection on their training journey and ultimately enhancing their sense of competence.

Enable users to log spontaneous scent experiences outside structured sessions, enhancing their data and creating a richer, more personalised view of their smell journey.

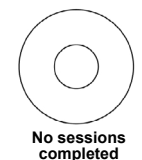
This supports both **autonomy and competence**. It fosters autonomy by allowing users to engage with training independently and enhances competence by providing opportunities to apply skills beyond formal sessions [9]. Logging spontaneous scent encounters extends training into real-world contexts, offering repeated practice and empowering users to take an active role, reinforcing autonomy [34].



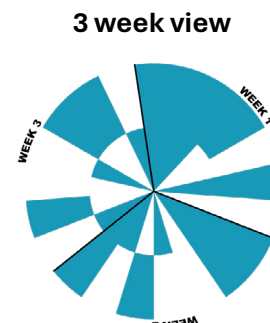
# 6 THREE DATA VISUALISATION CONCEPTS FOR DST

The first two authors convened every week for a month to conceptualise and embody the design directions into three concepts. In line with RtD practices, we prioritised exploring alternative ways of embodying the directions, rather than simply searching for the ultimate solution [37].

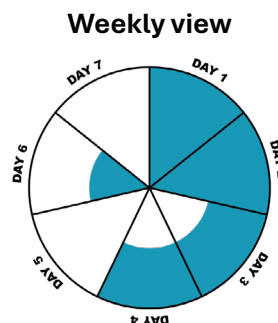
## Adherence data



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## Daily view

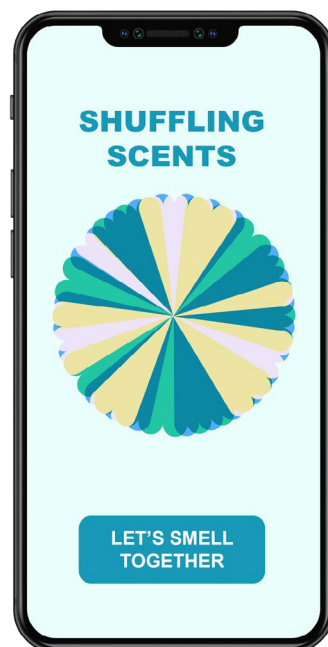


## CONCEPT 1: RADIAL

In this concept, adherence data is presented through a circular visualisation, with segments representing morning and afternoon training sessions. The inner part of the circle is filled upon completion of the morning session, while the outer part is filled after the afternoon session (Figure 9). The wheel can be divided into weeks or days (Figure 10), depending on the participant's preference for the level of granularity they want to see in the data.

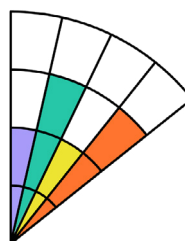
In line with DD1, participants can switch to their perception view (Figure 11). Here, the wheel segments are further divided into four to represent the four scents used during training. This concept adopts a more 'scientific' approach to data visualisation compared to the others.

To develop it further, we explored the idea of softening the data visualisation by transforming the data wheels into flower-like shapes (Figure 12). This could lead to badge designs, which could enhance adherence or be shared with others as a way to connect, relate, or simply collect mementos of a participant's journey.

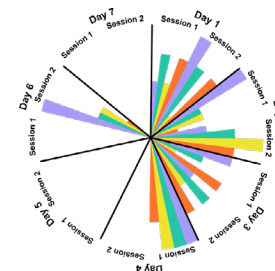


## Perception data

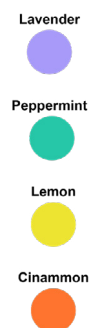
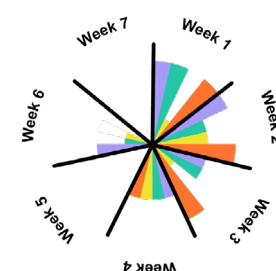
### Daily view



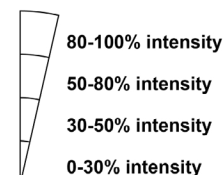
### Weekly view



### Monthly view



Intensity = height



### Organic view



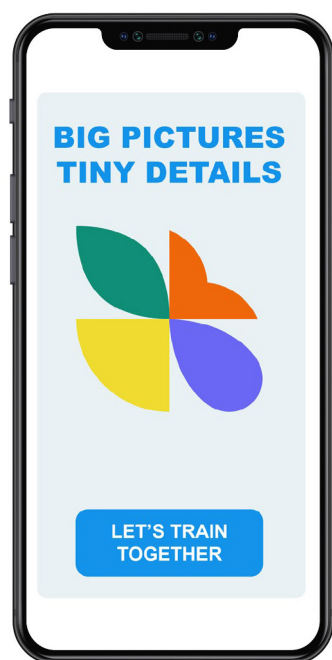
11



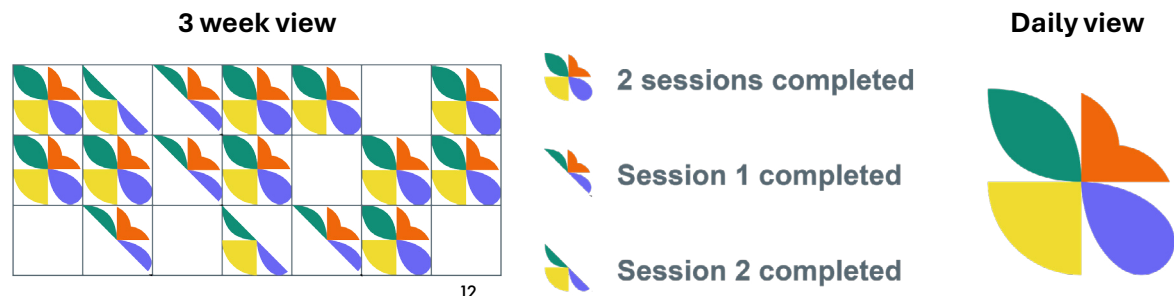
## CONCEPT 2: MOSAIC

This concept uses simple geometric shapes divided into quadrants to represent adherence and scent perception data. In the initial view, the quadrants are split diagonally to track adherence (Figure 13), with each quadrant representing one or two completed practice sessions.

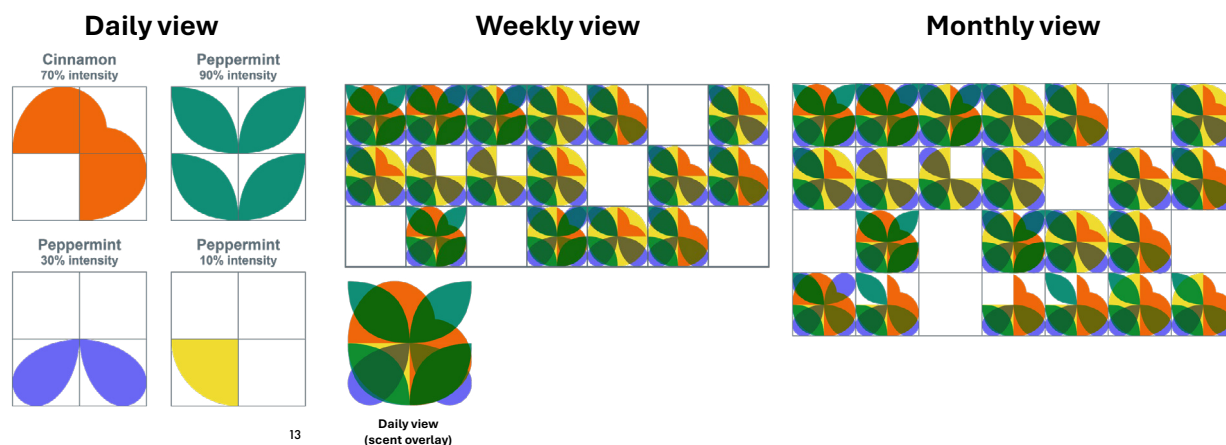
In the perception view (Figure 14), the quadrants are always filled, even when a participant cannot identify a particular scent, such as when the perception rating is 0-10%. This approach ensures participants are not discouraged by 'empty' spaces. The resulting shapes for the perception data layer over one another, forming a puzzle-like piece that can be viewed on a weekly or monthly basis. At first glance, the shapes of the four scents merge into a mosaic, a metaphor that could later emphasise a community aspect.



### Adherence data

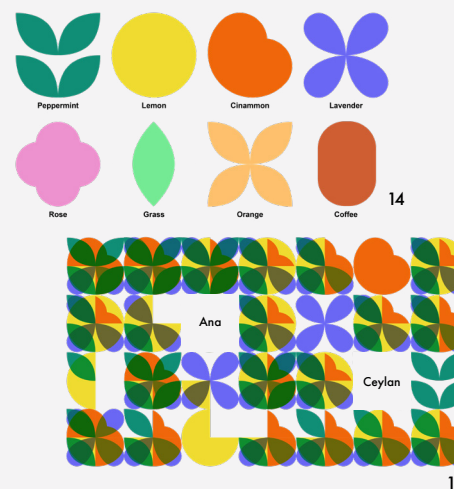


### Perception data



### Tailored feedback, Sense of Community and Scents in-the-wild

All concepts incorporate tailored feedback and promote a sense of community. In Concepts 2 and 3, we introduce a shared community wall where participants contribute their data as individual pieces or bouquets. These visual elements grow and evolve with each contribution, fostering connection, support, and healthy competition. The option to log scents encountered outside the training (e.g., coffee, Figure 15) adds another layer of engagement, highlighting the broader journey toward olfactory recovery.



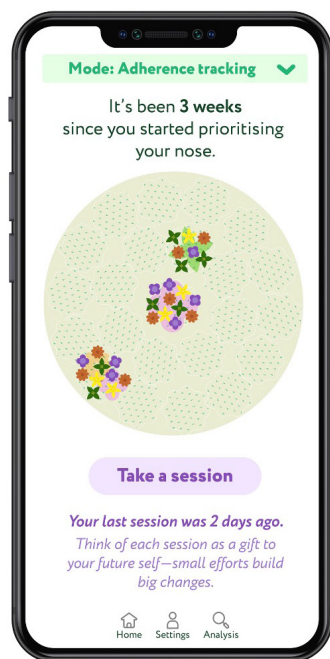
**Mosaic 'Community Wall':**  
In Concept 2, participants select a piece of their data to add to a shared community wall, where all contributions form a beautiful mosaic (Figure 16). These pieces randomly flip to reveal the names behind each data point, humanising the information. The goal is to share both successes and challenges in a spirit of community, camaraderie, and support.

## CONCEPT 3: BLOOM

Taking a more metaphorical approach, Concept 3 represents adherence and perception through flowers and bouquets. The title 'Flipping Perspectives' reflects our goal of shifting participants' views on their adherence and perception data. This change in perspective emphasises the connection between consistent training and perceptual growth, encouraging participants to view their progress from multiple angles and fostering a more holistic understanding of their journey.

We begin with a bird's-eye view of bouquets, each representing participants' adherence data on a monthly or weekly basis (Figure 17, left). The shift to a side view (Figure 17, middle and right) offers deeper insight into adherence by revealing the full flowers, with roots still growing in the daily view and the bouquet forming at the end of the week.

The daily perception view (Figure 18) gives a more detailed look and displays individual scents as flowers on a perception graph, with growth representing participants' perception data. Users can choose to view this data for each scent individually. We kept our aim of not having 'empty' spaces even where scent perception was low. For this, we included a visual of 'roots' as an analogy for participant's effort even if it was not yet visible.



### Adherence data

#### Weekly adherence bouquet

Top view



Side view



#### Daily view of growth

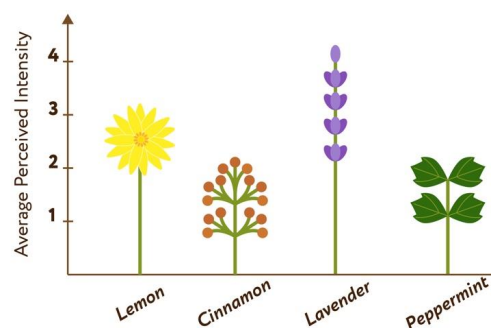
Day 22



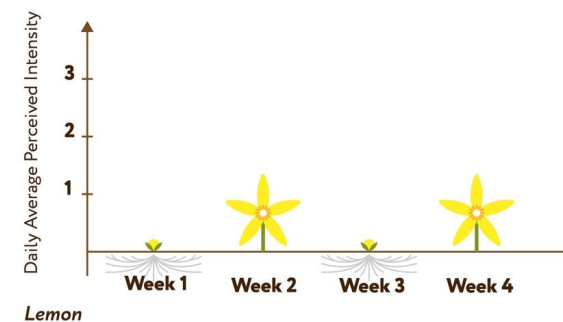
16

### Perception data

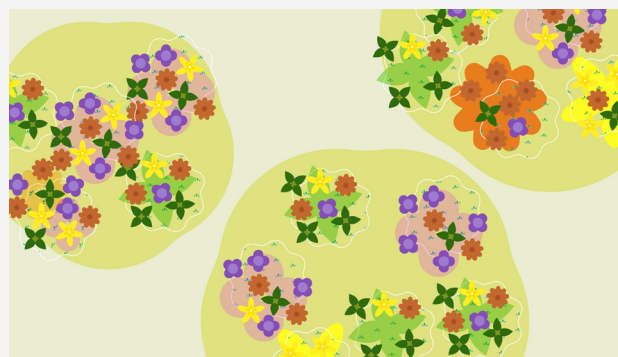
#### Daily view of average perception



#### Scent-specific view of perception



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#### **Tailored feedback, Sense of Community and Scents in-the-wild**

Bloom 'Community Garden': Our community garden adopts a similar concept to 'Mosaic', where participants select bouquets from their individual data. These bouquets are then placed into geographical areas, groups, or categories. The visual areas expand or contract based on participant engagement; the more adherence and perception data they contain, the larger they become. This approach encourages healthy competition among participants, motivating them to maintain daily practice sessions and share their personal journeys to connect with and inspire others.

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# 7 FOCUS GROUP ON DESIGN CONCEPTS

Building on the three concepts developed in Section 6, we conducted a focus group discussion with participants to prompt reflection on the proposed designs and their underlying design directions.

## 7.1 METHOD AND PARTICIPANTS

A semi-structured session with five participants from the field study explored eight design directions and three data visualisations. The 1.5-hour session began with a brief introduction, followed by a 20-minute presentation of the visualisations, with participants given printouts to review and annotate. We presented the three concepts as a visual journey, transitioning from a scientific/geometric approach (Concept 1 & 2) to an organic one (Concept 3). This mirrored our design process, evolving from standardised to figurative viewpoints. The latter incorporated gamification and allegory, aiming to enhance participants' experiences and encourage data input through engaging visual and emotional rewards.

Using the printouts, participants rated each concept on a scale of 1 to 5 (1 = Weak Accept, 5 = Strong Accept) for clarity, positive impact on their DST experience, and visual appeal, and also annotated their thoughts. Then participants were asked to share their thoughts, with the session then shifting to open-ended discussions. Overall, participants provided their thoughts on the concepts, reflecting on the benefits and drawbacks of each approach.

Notes and printout assessments were analysed using inductive thematic analysis [23], categorising feedback into clarity, motivation, and engagement to inform the refinement of the design directions.



## 7.2 FOCUS GROUP FINDINGS

### 7.2.1 CONCEPT 1: SIMPLICITY THAT WORKS - BUT COULD INSPIRE MORE

Clarity: 4.33, Positive Impact: 4.17, Visual Appeal: 4.17

Concept 1 'Radial' was appreciated for its simplicity and clarity, though some participants raised concerns about its mathematical accuracy. The circular design used slices to represent sessions, but the area of each slice increased with the radius, leading to misrepresentation of progress. A more intuitive approach would involve making slices proportional to session numbers. While the design was valued for its clarity, some found it too scientific and lacking in imaginative appeal.

### 7.2.2 CONCEPT 2: INTRIGUING ABSTRACTION VS. PRACTICAL USABILITY

Clarity: 3.83, Positive Impact: 4.17, Visual Appeal: 4.33

Concept 2 'Mosaic' received mixed feedback. Some participants found it too abstract and congested, preferring more literal icons, while others appreciated the graphic nature of the concept. The overlay view was challenging to understand for most users, although some found the abstraction intriguing. Overall, the complexity hindered its clarity for certain participants.

### 7.2.3 CONCEPT 3: GROWTH-ORIENTED DESIGN, BUT OVER-EMBODIED FOR SOME

Clarity: 4.17, Positive Impact: 4.17, Visual Appeal: 4.50

Concept 3 'Bloom' was the most engaging and motivating, with participants highlighting its focus on growth as particularly encouraging and fun. The metaphor of "seeing things grow" resonated strongly, evoking positive emotions and a sense of accomplishment. A few participants noted it was somewhat embellished, contrasting it with the abstractions in Concept 2. Concept 3 was seen as adaptable and emotionally impactful, making it the most positively received.

### 7.2.4 STRIKING THE BALANCE: COMMUNITY, PROGRESS TRACKING, AND EVOLVING VISUALS

Across all concepts, participants emphasized the importance of finding a balance between figurative and abstract representations, appreciating both but suggesting that neither should dominate. There was strong support for community features, with peer-to-peer support seen as more effective than top-down guidance. For design directions, participants favoured an adherence-first approach, emphasizing tracking completed sessions over perceived intensity ratings to sustain adherence.

To maintain motivation over long training periods (up to two years), participants suggested updating the visual style every 2-3 months. For example, in Concept 3, the bouquet could evolve into different objects or representations, while Concept 2's abstract icons could undergo subtle changes to refresh the visuals.

## 8

## REFLECTION AND CONCLUSION

This pictorial explores **how data visualisations in DST can foster motivation and adherence**, drawing on insights from the first-ever qualitative study on individuals' experiences with DST at home. The research, conducted with 18 participants aged 45-75 in the UK over a six-month period, extends to broader digital health interventions requiring sustained user engagement.

Guided by RiD, the study involved deploying a technology probe, gathering participant insights through interviews and a co-design workshop, and iterating on design concepts based on behaviour change theories. The focus group played a pivotal role in refining the design directions and deepening our understanding of user needs.

Instead of **endorsing a single visualisation**, the focus group feedback was instrumental in refining and reprioritising the design directions (DDs) presented in Section 3, ultimately shaping the evolution of the design concepts. Based on this feedback, an adherence-first approach (DD1), which prioritises visualisations that celebrate achievements and encourage continued engagement, emerged as the primary design direction. This aligns with the concept of 'care frictions' in healthcare technology design [7], where tensions arise between clinical best practices and the practicalities of users' everyday lives.

Participants also favoured peer-to-peer support over top-down guidance, reinforcing the importance of community features in fostering shared motivation. This reinforces findings from HCI research [6] on the role of community in providing emotional support and helping users adapt to their conditions. Additionally, participants recommended periodic updates to visual styles to maintain novelty and long-term motivation, leading to the design direction (DD9) of embedding adaptability into the visualisation framework.

Overall, the feedback led to a **hierarchy of priorities**: adherence-focused visualisations, followed by motivational and interpretable designs, and finally, community-oriented perspectives on data.

The insights from this research extend to other digital health applications, such as stroke rehabilitation [21] and chronic illness management [3]. Future research should explore the personalisation of visualisations based on individual data and goals, to further enhance user motivation and empower users in their health journeys. This work contributes to the **broader conversation on research through design** [8, 37], providing a foundation for future studies on how data visualisation can sustain long-term adherence and motivation in digital health interventions.

## 9

## FUTURE WORK

Building on the insights from this study, expanding the research to include a broader range of olfactory abilities and geographical contexts beyond the UK will be important for evaluating the applicability and effectiveness of these design directions across diverse user groups. While this study intentionally avoided analysing perceptual change data, as its primary aim was to understand user engagement with DST rather than its clinical efficacy, future research should explore the relationship between DST design features, such as data visualizations, and changes in olfactory function. Although the effectiveness of smell training is well established in medical research [28], a clinical study specifically examining the efficacy of DST in olfactory rehabilitation is needed.

DST could be integrated with digital health platforms and wearables to support personalised care. App data could link to electronic health records, while wearables might extend feedback beyond sessions. Given participants' recognition of mood and weather influences, future work could explore using wearables for emotion recognition [36] and environmental data to suggest optimal training times. However, such integrations must maintain DST's core strengths: simplicity, speed, and ease of use [5].

We also see opportunities to expand DST through tangible and embodied interaction [18]. While the probe included the adherence wheel, this pictorial focused on 2D interface design. Embodied engagement is currently limited to scent delivery, with little happening during the session itself. Early examples from olfactory therapy, such as an odour ball used in occupational settings, suggest that simply holding a training tool can support engagement even without digital features. Building on this, real-time tangible feedback could enhance the experience, drawing on growing HCI work in behaviour change [38] and mental health [33].

We invite the DIS community to refine and expand upon our DST design directions and the future opportunities outlined here, advancing DST and the development of data visualisations that promote long-term, meaningful engagement in olfactory health and wellness.



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