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From Smells to Stories: *The Design and Evaluation of The Smell Memory Kit*

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The study presented is a research through design of the motivational, story sharing effects of smell, within the context of addiction care. This investigation led to the co-design of the Smell Memory Kit: a kit using eight selected smells as motivational elements to evoke and share autobiographical episodic stories among addiction care clients. A pilot evaluation study with clients ($N = 14$) of the Kit showed the potential of its effect in evoking and sharing episodic autobiographical stories. Moreover, qualitative analysis of the data links the distinct smells to four qualities of the autobiographical stories (i.e., emotion, clarity, specificity, and age). The research outcomes are promising in depicting the use of smells as *sense data* to effectively encode practices and experiences which can later be retrieved as simulations through an encounter/exposure to an odour. With regard to design, the present study shows that smells can perfectly function as a design material for storytelling, and more specifically as promising game elements in persuasive game design, motivating clients to elicit and share rich episodic memories.

Keywords – Research Through Design, Persuasive Game Design, Smell, Memory, Embodied Knowledge, Addiction Care Therapy.

Relevance to Design Practice – The present study argues for the relevance of smell as a design material, for an embodied practice of sensory imagining that can evoke storytelling through sensory design research.

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Introduction

> But when from a long-distant past nothing subsists, after the people are dead, after the things are broken and scattered, taste and smell alone, more fragile but more enduring, more unsubstantial, more persistent, more faithful, remain poised a long time, like souls, remembering, waiting, hoping, amid the ruins of all the rest; and bear unflinchingly, in the tiny and almost impalpable drop of their essence, the vast structure of recollection. (Proust, 1918/2003, p.51)

This paper presents a research through design (RtD) study, highlighting the potential of smells as motivational game design elements, facilitating storytelling through the evoking and sharing of autobiographical stories. The research is structured as a RtD process (Cámara Leret, 2014) involving the following sub-phases: 1) the realisation of smell sessions to research the evocative potential of smells, 2) the design of smell webs to explore the narrative relationships among a set of smells, 3) prototyping of the Smell Memory Kit (SMK), including sets of smells and interaction instructions, and finally 4) an evaluation of the SMK in terms of the narrative and memory-related qualities of the smell evoked stories.

The RtD investigation was performed working alongside patients and clinicians from Parnassia Brijder PARC Mistral addiction care center in The Hague. Clients in mental healthcare were chosen as the target group since they are typically refrained in sharing autobiographical stories. Evoking interpersonal communication among them, such as autobiographical story sharing, is thus expected to increase their therapeutic relationships, positively promoting experiences of safety and trust (Gilburt, Rose, & Slade, 2008).

This paper presents the underlying smell-related psychological theory of the SMK, the co-creative RtD process and the results of our (qualitative) evaluation study on story generation by smell. The paper will end with a discussion on the relevance of designing with smell, offering insights on the potential use of smells as motivational elements for persuasive game design.

Persuasive Game Design

A game world is typically experienced as containing symptoms such as being engaging, creative, free, and explorative. Moreover, the embedded protective frame (Apter, 2007) in the game world motivates the user to explore their behaviour more freely since the real world consequences of their actions are limited; for instance, loosing money during a game of monopoly has less consequences for your real world experience than loosing money in the real world. Gamification is designed to transport (Green, Brock, & Kaufman, 2006) the player's experience from a real world towards this engaging game world experience.

In persuasive game design, the game world experience has

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not only the purpose of entertaining the player as books or movies do, but also to increase the player's motivation for achieving an aimed-for transfer goal in the real world. For instance, a game world can be elicited to facilitate physical behaviour for people with dementia (Anderiesen, Scherder, Goossens, & Eggermont, 2015), to facilitate audience participation (Visch, 2017) or to facilitate social coherence of employees (Vegt, Visch, deRidder, & Vermeeren, 2015) or in city neighbourhoods (Visch, Mulder, Bos, & Prins, 2014).

The present research adheres to persuasive game design in providing insights on the potential role of smells as motivating game elements that can transport players to a game world experience of memory recollection, facilitating storytelling, and sharing. In this case, the aimed-for transfer goal would reside on autobiographical story generation and sharing amongst youngsters in mental healthcare programs. Nonetheless, the focus of this paper is not on the realisation of the behavioural transfer through smell design, but rather on providing insights on the potential of smells for design research and as persuasive game elements. The therapeutic transfer effect, i.e., therapeutic effectiveness of story sharing on social relationships, is not addressed in this qualitative and research-through-design oriented study.

Smell Memories

There are manifold combinations of the basic molecules that compose all the (human) perceived smells in the world (Gilbert, 2008). A smell is a chemical detection of volatile molecules, light enough to evaporate and reach our noses. Smells are everywhere, and through our olfactory experiences we subconsciously establish associations to our surroundings. These emotional recollections precede and differ from any understanding or description of the odour (Herz, 2011). With one sniff, we can be transported to a childhood event, bringing the experience into the present through its associated *smellscape*. Fiction literature has long used this associative power of smell to describe strong sentimental recollections triggered by odours. *Swann's Way* (Proust, 1918/2003) coined the term *involuntary memory* to define recollections of the past elicited by flavours and smells:

> And once I had recognized the taste of the crumb of madeleine soaked in her decoction of lime-flowers which my aunt used to give me (although I did not yet know and must long postpone the discovery of why this memory made me so happy) immediately the old grey house upon the street, where her room was, rose up like the scenery of a theatre to attach itself to the little pavilion, opening on to the garden, which had been built out behind it for my parents (the isolated panel which until that moment had been all that I could see); and with the house the town, from morning to night and in all weathers, the Square where I was sent before luncheon, the streets along which I used to run errands, the country roads we took when it was fine. (p. 51)

Research into this so-called Proust phenomenon has shown the ability of odours to spontaneously elicit involuntary, autobiographical memories (Chu & Downes, 2000). These odour-memories are emotionally toned, possibly due to the olfactory system's anatomical link to the amygdala-hippocampal complex of the brain's limbic system, critical for the expression and experience of emotion (Aggleton & Mishkin, 1986) and human emotional memory (Cahill, Babinsky, Markowitsch, & McCaugh, 1995). The familiarity of an odour is related to its potency to evoke a memory (Herz & Cupchik, 1992; Rabin & Cain, 1984). Herz (1997) furthermore suggested that if odour encoding takes place in an emotionally heightened context, increased limbic activation may cause the connection between the odour and the event to become stronger, than if it were to occur in a non-emotional context. In this manner, when the odour is later encountered, it can precipitate the memory of the target event, as well as a cascade of emotional experiences. Moreover, a review of cognitive literature on olfactory memory (Herz & Engen, 1996) shows that olfactory memory has several important distinguishing characteristics (in comparison to visual-verbal memory). Supporting the theory that emotion is key in the formation of autobiographical odour-evoked memories, Herz and Engen conclude that memories elicited by odours "appear to be more emotionally potent than those evoked by other sensory stimuli" but also that "contextually distinctive odours are specially good retrieval cues, possibly because they elicit affect."

Embodied Accounts

Tuvling (1972) differentiated between semantic and episodic memory types, regarding them as two information processing systems. Semantic memory is defined as the memory necessary for the use of language, being less susceptible to involuntary transformation and loss of information than the episodic memory system. As a *mental thesaurus*, semantic memory includes words and verbal symbols, their meaning and referents, relations among them, rules, formulas, and algorithms for the manipulation of these symbols, concepts, and relations. Episodic memory, on the other hand, stores information about temporally dated, perceptual events, and temporal-spatial relations among these events. For example, as in Proust's quote above, whereas semantic memory might contain information about what a madeleine is, episodic memory contains information about the experience of eating a specific madeleine in a place, time, etc. As a record of a person's experiences, episodic memory therefore represents autobiographical events (times, places, associated emotions, and

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Valentijn Visch works as an assistant professor in the Faculty of Industrial Design Engineering at Delft University of Technology. He conducts and coordinates persuasive game design research, and is project leader of the CRISP G-Motiv project (2011-2015) and the NextLevel project (2013-2017). Both research projects encompass research as well as industry and end-user partners. Valentijn has a background in literature (MA), art theory (MA-postgraduate, Jan van Eijck Academy), animation (postgraduate, NIAF Tilburg), cultural sciences and film studies (PhD, VU University Amsterdam), and experimental emotion research (UniGeneva, Erasmus Rotterdam).

other contextual knowledge) extending beyond the bare facts of an event. It therefore also includes the emotional charge, such as the happiness precipitated through the flavour experience, and the entire context surrounding its occurrence, such as the house, environment, weather, social relations, and activities. As with the madeleine's flavour, the emotional encoding of smells through experience turns them into effective episodic memory cues for a heightened recollection of autobiographical stories.

This capacity of olfactory experience to evoke rich episodic memories can be addressed through embodied accounts of the human psychological and cognitive system. Most notably, the phenomenologist Merleau-Ponty (1962/2002) elaborated on the body as a *synergic system*, considering its functions as 'exercised and linked together in the general action of being in the world':

> The body is the vehicle of being in the world, and having a body is, for a living creature, to be intervolved in a definite environment, to identify oneself with certain projects and be continually committed to them (…) I know that objects have several facets because I could make a tour of inspection of them, and in that sense I am conscious of the world through the medium of my body. (p. 94)

Incoming *sense-data*, such as smells, contribute to this holistic *sense-experience*, understood as a cognitive function where the body becomes a meeting point or *host of causalities*. The body is understood as *one of the objects* of the world and through enactment it reveals "the perceiving subject as the perceived world":

> To the extent that I have 'sense organs', a 'body', and 'psychic functions' comparable with other men's, each of the moments of my experience ceases to be an integrated and strictly unique totality, in which details exist only in virtue of the whole; I become the meeting point of a host of 'causalities'. In so far as I inhabit a 'physical world', in which consistent 'stimuli' and typical situations recur-and not merely the historical world in which situations are never exactly comparable–my life is made up of rhythms which have not their 'reason' in what I have chosen to be, but their 'condition' in the humdrum setting which is mine. (Ponty, 1962/2002, p.96)

In his model of embodied cognition, Barsalou (Barsalou et al. 2008) turned this phenomenological notion of the embodied experience into a cognitive account of multisensory experiences, integrating Tuvling's semantic and episodic memory types. According to Barsalou et al., incoming perceptions are reflected in our body by simulations of stored related experiences. These stored experiences are interrelated multisensorial experiences including cognitions, emotions, and the senses. For instance, seeing the love symbol of a heart might not only evoke understanding of the symbol, i.e., love, but also evoke multisensory memories of past events including affects, e.g., the thrilling excitement of nervously exchanging hearts to a beloved during classes in high-school. For the purpose of this paper, semantic and episodic memories can thus be addressed as intertwined within the recollection of multisensory experiences. The processes behind the forming of these memory-types lies outside the scope of this paper.

From Smells to Stories in Addiction Care

The SMK uses the involuntary aspect of smells to evoke rich, embodied recollections, making the resulting multisensory memories explicit in social communication. The unusual intensity and evocativeness of odour-evoked memories adds a life-like quality to these accounts (Herz, 1997). More recently it was demonstrated (Herz, 2004) that olfactory stimuli can cue these episodic memories, 'highly vivid, affectively toned and very old', more effectively than cues from other sensory modalities. Strong, emotional episodes are more easily recollected by smells, leading to conclude that the emotional experience facilitates the recollection of the memory by the smell. Smells therefore offer a rich glimpse into autobiographical experiences, as *retrieval cues* of 'salient contextual features from the immediate environment in which the episode was experienced' (Chu & Downes, 2000).

In this sense, the use of smell as a story sharing medium can be considered a means for creating 'sites of embodied knowledge, to investigate individual autobiographical past experiences implicated in the [emotional] construction of place in the present' (Pink, 2009). This encoding process was identified (Largey & Watson, 2006) in contributing to the creation of an *olfactory identity*, since *olfactory imagery* is involved in much moral symbolism relevant to interaction (Largey & Watson, 2006). Smell-memory is thereby a means of expression, communicating social categories linked to the construction of meanings derived from individual, lived experiences. The sharing of autobiographical smell-memories can be understood as *relational schemas*, through which people internalise their relationships with others, influencing their experience of subsequent relationships and their sense of self (Baldwin, 1992).

The smelling experience becomes challenging, as in gameplay, when the smell is decontextualised, motivating people to recollect the matching memory. Like Proust's involuntary memory recollection, experiencing the memory but not (yet) able to find the fitting wording or connotations for it, turns the act of smelling into a motivating, embodied adventure, attempting to describe or situate the smell within a previous happening. Therefore, smells can be expected to be strong motivational game elements, as their involuntary memory triggering is motivating for interaction or play. The resulting olfactory game-world playful experience is likely to be motivated by the play experience of challenge: participants are persuaded to connect episodic memories to the incoming smell stimuli and are challenged to find the appropriate stories. Our RtD aim is thus to explore and guide this process, from the involuntary feeling of recollection of a memory towards a verbally shared, rich story.

This aim is intrinsic to the research context. Although the clients resided at the care centre during a period of two to four months, they were hesitant to share personal information among themselves as they did not know each other. Part of the therapy therefore aims to stimulate social relatedness amongst the clients. Considering smell-memories as simulations of episodic events, we propose they can contribute to the sharing of personal information in the form of autobiographical stories amongst the

clients. Through an iterative, design led, sensory research process we thus explored the use of smells as memory cues to facilitate a low-risk context for the retrieval and sharing of autobiographical events. The insights from the research highlight future possibilities for the use of smell in design, for example as motivational game elements in persuasive game design.

RtD Process: *Designing the Smell Memory Kit*

The research through design (RtD) methodology employs designed artefacts (prototypes in the form of products, visuals, etc.) as a means to stimulate other [non-scientific] forms of knowledge within field research (Gaver, Dunne, & Pacenti, 1999). Through the creation of *experience prototypes* and conceivable narratives or scenarios, design draws the public into the process itself and involves them directly in the definition of potential outcomes (Gaver et al., 1999). In the present SMK case, the design of smell sessions responded to a *thinking by making* approach, or *learning by doing* as it is known at Design Academy Eindhoven, to involve the clients into the research process from the beginning. This hands-on, design research process involves iterative prototyping, which in this instance informed the design of smell-webs, leading to the design of the SMK. The RtD developed at Mistral Rehabilitation Clinic was defined by the four phases as presented in Figure 1.

At the intake interview in Mistral clinic, clients are asked to share their life stories. This first conversation between clients and clinicians was identified as stressful by the clients, as some personal recollections tend to elicit strong, conflicting emotions. Following acceptance, the therapy is mainly focused on improving function without the use of agents, gambling, or gaming, increasing necessary skills for coping with addiction/other psychiatric problems and the social environment, psychoeducation, and rehabilitation. Therapy is complemented through a client-support system, where clients are normally assigned another (more advanced) client as a *buddy* to introduce them into the dynamic of living in the clinic, supporting them throughout their stay. Clients are stimulated to confide in their buddies, and their life stories are often referred to as *health narratives*, as they often reveal behavioural patterns that can aid or hinder treatment (Spijkerman & Cámara Leret, 2013). The research through design started by exploring these first conversations, through various sensory design interactions (Cámara Leret, 2015).

RtD Phase 1: *Smell Sessions*

For Smell Session #1 (see Figure 1), we explored if smells could stimulate conversations amongst the clients. We worked with a group of six clients, aged 14-22 years old, participating on a voluntary basis and supervised by the clinic's principal psychologist. In collaboration with the company International Flavours and Fragrances (IFF), experienced perfumers selected 11 composed fragrances expected to be relevant to the cultural context and target group and to elicit specific memories and related emotions (for example in relation to childhood or lifestyle).

The samples consisted of *zwitsal* (a Dutch brand of baby products), *speculaas* (a Dutch, cinnamon-like biscuit associated with comfort food or the home), *cave* (evocative of humid climates, nature, or indoor spaces such as cellars), *not sweety*

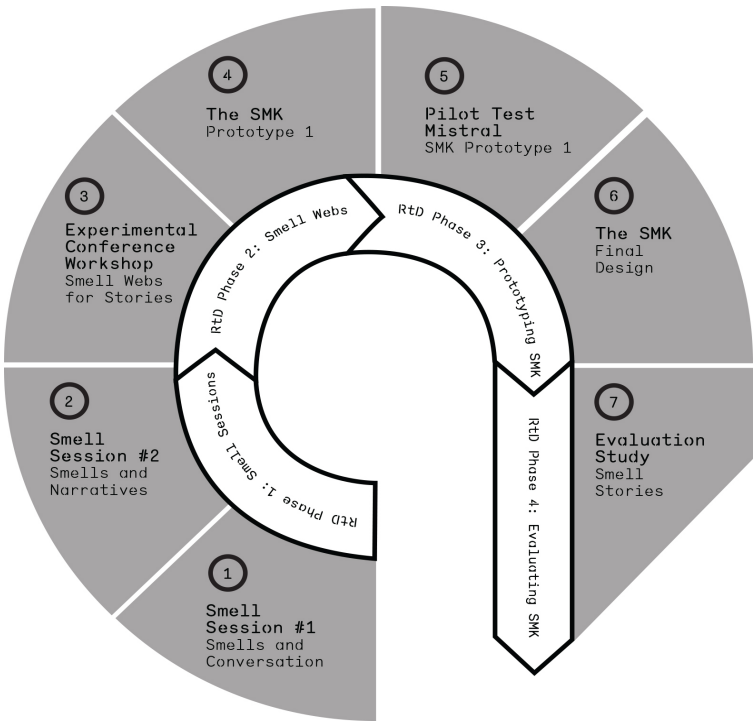


Figure 1. Overview of the RtD process: Designing the SMK.
Consisting of 2 smell sessions (*N* = 6), 1 experimental conference workshop (*N* = 12), design of the SMK prototype 1, 1 pilot test at Mistral rehabilitation clinic between 1 client-buddy pair (*N* = 3), followed by final design of the SMK, and evaluation study (*N* = 14).

(reminiscent of body odour or musty smells), *grass* (fresh, nature-like smells such as grass or green apple), *brood* (the smell of bread or sourdough), *txocolat* (chocolate, sweet smell), *civet dil* (a strong, animalistic odour originating from the glands of the civet), *drop* (the odour of licquorice candy, widely consumed in the Netherlands), *burn out* (a blend ressembling a spicy perfume or incense), and *spearmint* (derived from mint and associated with cosmetic products such as toothpaste). These were prepared at recommended concentrations for average intensity and applied to polymer pellets. Each participant was given 30 ml opaque white jars, numbered (from 1-11), containing the pellets. To smell the samples, clients unscrewed the lid off the jars and sniffed the contents. Clients never saw the odourants and there were no visual differences between the samples. Following the advice from IFF perfumers, participants were given subjective instructions, asked to focus on their personal, immediate emotional and physical experience with the smell, and asked to smell each fragrance blindly. Firstly, they were asked to react to the question: What is the first thing that comes to you? Writing down or sketching their memories, feelings, or initial reactions to the smell. Secondly, they were asked to respond to: How does it make you feel or what do you remember?

Smell Session #1 showed that clients were willing to work with smells and that smells stimulated conversations (see Figure 2) amongst the participants, although they had been instructed to keep their smell associations private. For example, the smell of txocolat reminded a client of his mother: "(...) the wintertime as a young child, drinking hot chocolate. It's a warm feeling that comes to mind. Reminds me of my mother who made the drink. Makes me feel happy." For another client the same odour was associated to a cosmetic product, reminding her of a previous partner: "The first time I smelled the new deodorant from my ex, Axe chocolate." Some smells, such as spearmint were associated with freshness, cleanliness, or pleasant feelings: "Fresh smell, toothpaste, clean smell, smell makes me wake up-concentrate." Other smells, such as brood, elicited mixed reactions: "It smells a little like a hardly ventilated room. It smells musty. It smells like a shoe (...) I was a bit sick."

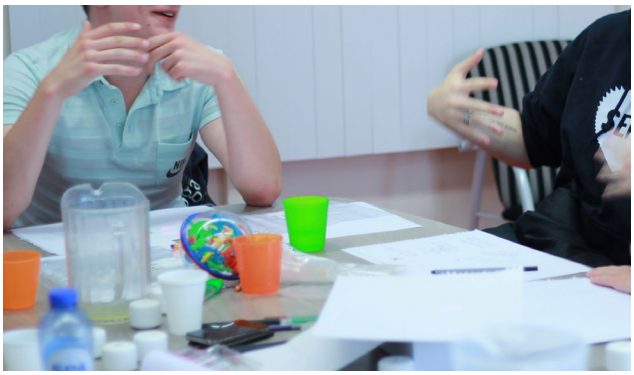


Figure 2. Clients were stimulated to talk about their memories during the Smell Sessions at Mistral.

Building on this outcome, Smell Session #2 was designed to explore if smell memories could be used to compose narratives for storytelling. A different delivery method was chosen, printing the samples on 6 × 6 cm squares in A4 cardboards, to allow the recording of the fitting memory directly onto the provided smell sample by writing or drawing on the paper. Because Smell Session #2 was supported by the Dutch company Helderzeefdruk, which specialises in printing smells, thus different odour samples were used. Maintaining the general categories from Smell Session #1 (such as flavours, nature, hygiene, etc.), the following odours were chosen: flavours such as chocolate and lemon, outdoor smells like cut grass, perfume, or incense related odours like burned wood, hygiene-related or fresh odours like soap and toothpaste, and finally less pleasant smells like sulphur, vomit, and sweat. This time, participants were asked to work visually by smelling each printed sample and directly illustrating the smells on the paper to create their own narrative storyboard (see Figure 3) inspired by their olfactory experiences.

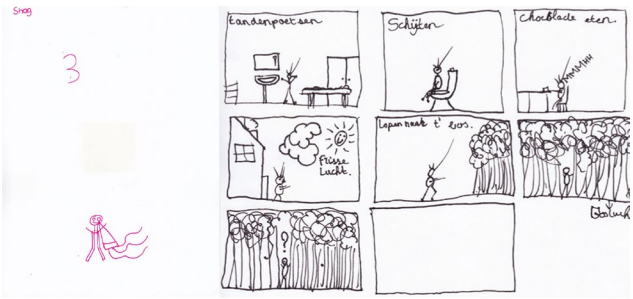


Figure 3. Clients were asked to illustrate their associations to the printed smells, creating a storyboard.

Smell Session #2 did not result in a clear outcome for the representation of stories. The majority of the clients struggled to translate their experiences into visual diagrams or sketches, as the brief was too broad for this target group, whom struggled with abstraction. We therefore limited ourselves to focusing on the sharing of smell-memories verbally, aiming for a more structured design to guide the process from smelling to story sharing.

The outcomes from Smell Session #1 and #2 led to the realisation that the very act of smelling elicited conversations (Cámara Leret, 2015). As noted by one of the clinic's psychologists: "smelling makes you want to talk." The abstract nature of the smell experience turned the *blind* act of smelling into a motivating activity for the clients, who attempted to guess the origin of each smell, sharing their experiences in the process. Furthermore, Smell Session #2 reinforced the relevance of sharing these stories verbally, rather than through visual representations, which proved too abstract an exercise for this target group. These observations shifted the focus of our research through design towards the very *act of smelling* and the use of smells as cues for the (verbal) sharing of autobiographical experiences. *Smells that make you want to talk*, became our new design brief.

RtD Phase 2: *Smell Webs*

A molecule of Rose Oxide, for example, smells *like a rose* because of the associations we have attributed to it (Gilbert, 2008). Nevertheless, this molecule (amongst others) also composes the flavour/fragrance of lychee. This naturally existing

and hyperlinked path of smell molecules–from the smell of rose to the flavour of lychee–provides a platform onto which personal experiences can be mapped through smelling. Various associations can therefore be linked to one molecule resulting from differing previous encounters and experiences with it.

In this manner, the molecular coherence of smell was implemented within our design to provide narrative coherence. We used this natural storyline of smell to design smell webs: maps tracing where specific molecules naturally coexist and co-create smells. For example, the molecule Methyl Mercaptan composes the smell of marijuana (see Figure 4) and is expected to evoke memories of marijuana, its use, etc. Nevertheless, Methyl Mercaptan also composes the smell of human feces and can also trigger memories associated with, for example, toilets. Thus, the exposure to a smell molecule can account for unexpected stories, based on how the molecule was first encountered. This two-fold characteristic of smell-memory ensures that the smell web's selection of molecules will lead to narrative coherence on the one hand, as a balanced group of (expected) personal memory types, but also unexpected (suppressed memories).

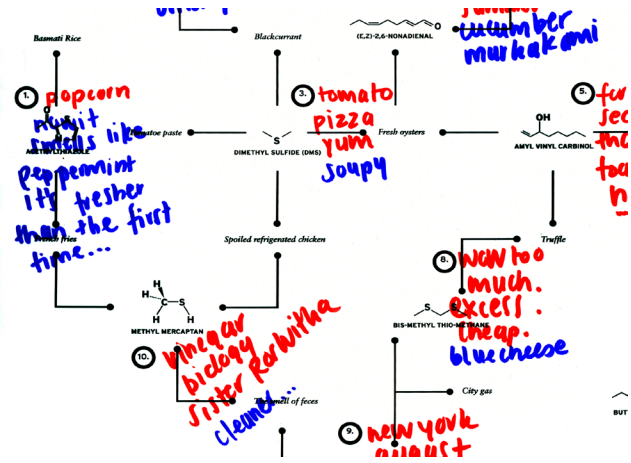


Figure 4. Section of the smell web designed for the experimental WDCDO (What Design Can Do) conference workshop. Participants were handed a numbered template to record their smell stories. Afterwards, an acetate template was provided containing information on the smells and their interconnectedness, placing it over their stories to compare molecular–story coherence.

A first iteration of a smell web was tested during the experimental workshop at What Design Can Do (WDCDO) 2013 design conference (see Figure 5). It presented participants with ten molecules associated with body and environmental smells: Butyric Acid (sweat, ripe fruit), Dimethyl Trisulfide (ripe fruit, city gas, faeces), Bis-methyl Thio-Methane (city gas, truffle), Amyl Vinyl Carbinol (truffle, fresh oysters, fresh lychee fruit), Cis-Rose Oxide (rose), (E,Z)-2, 6 = Nonadienal (fresh oysters, beef, cucumber), Dimethyl sulphide (fresh oysters, spoiled refrigerated chicken, tomatoe paste, black currant), Mercaptomethylpentanone (black currant, Heineken beer, cat urine), Methyl Mercaptan (spoiled refrigerated chicken, faeces), and Acethylthiazole (basmati rice, french fries). The smells were prepared by IFF at recommended concentrations for average intensity in liquid dilutions. Groups of four to six participants from mixed backgrounds were provided with numbered, white, smelling paper strips (or blotters), previously dipped in the corresponding sample, water jars to discard these and avoid air saturation, and coffee beans to recalibrate the nose. Participants were given subjective instructions, to focus on their personal, immediate emotional and physical experience with the smell, and asked to smell blindly whilst provided with A3 templates to record their smell experiences (see Figure 5). They were asked to react (by writing, sketching, etc.) to the question: What is the first thing that comes to you? Secondly, they were asked to respond to: How does it make you feel or what do you remember? A3 acetate sheets with information on the links between the molecules were provided (see Figure 4), and these were placed over the recorded stories to compare molecular and story coherence for the end discussion.

Figure 5. Recording personal smell stories during the experimental WDCDO conference workshop.

The insights from this second RtD Phase indicated that sharing personal anecdotes or stories was easier through a shared referent (a smell molecule), despite the different interpretations (Raijmakers, 2013). Thus, working with molecules for the design of smell webs provides an underlying structure to explore hyperlinked experiences between clients. These outcomes were used to design a second smell web, to be implemented in Mistral clinic.

RtD Phase 3: *Prototyping the Smell Memory Kit*

In consultation with the principal psychologist from Mistral clinic, and building on client responses from the Smell Sessions, a total of eight molecules were selected (Cámara Leret, 2014) creating a smell web (see Figure 6) as input for the first prototype of the SMK. Coherent memory types were found from analyzing the outcomes from Smell Sessions #1, #2, and the WDCDO conference workshop. These were mainly: Childhood (positive smells such as Methyl Anthranilate, normally found in candy as fruit flavouring, and universally perceived as soothing, such as Vanillin or negative/alarming ones such as Dimethyl Trisulfide, the smell of city gas), Drug-related (molecules found within marijuana such as Beta Pinene or Methyl Mercaptan), Body Odour, Nature, Built-Environment, and/or Weather (such as Geosmin, found in the smell of rain or wet soil, Methyl Mercaptan found in human faeces or Õ-Terpinene, found in the smell of plastics).

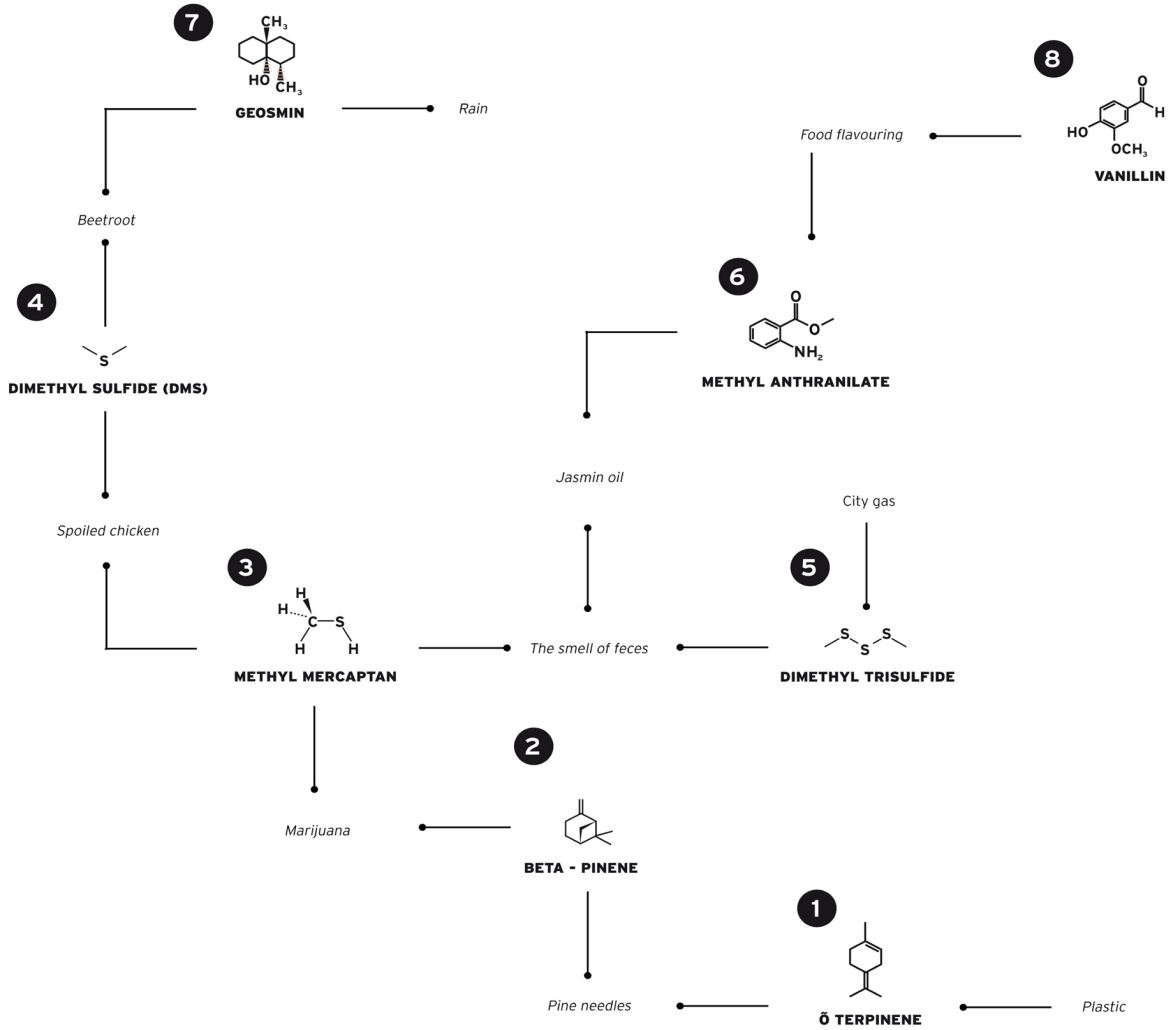


Figure 6. The smell web designed for the Smell Memory Kit.

A first prototype of the SMK was developed with IFF's technological support, coating a series of polymer pebbles with the molecules for more longevity and to avoid spillage. As these molecules are found in nature, their use is open and patent-free. The kit was accompanied by a manual (Figure 7) with detailed instructions on how to smell as indicated by experienced IFF perfumers and background information on smell memory and storytelling. The manual also included a description of the aims and set-up of the exercises, to guide client and buddy through the smelling and story exchange process. The back of the manual contained a diagram of the smell-web, providing information on the origins of the smells.

This first prototype of the SMK was tested during a *blind* pilot test in Mistral clinic (see the design research process in Figure 1), with one client-buddy pair, supervised by a clinician. The clinician was provided with the manual (Figure 7) in advance of the session, clarifying the goal of the session, i.e., smells to generate personal memories, and that the session was not about *winning* or *guessing* the origin of the smells. The manual furthermore provided the clinician with a stepwise procedure for the smelling activities. Amongst interaction rules, such as *smelling tips* and alternate smelling turns, the manual provided questions to motivate storytelling (e.g., asking about the place, time, social context, event, and associated emotions of the memories). Client and buddy (another more advanced client) were asked to blindly smell each sample and write down their first impressions, feelings, or memories triggered by the smell. After smelling for a second time, they were asked to expand on their recollections and experiences with each smell, slowly leading to an exchange of memories.

During this process, the client explained that the smells had become *the object of the conversation*, and as there was no right or wrong answer and it is the personal experience that mattered, tensions experienced in speaking about *himself* were alleviated. Furthermore, the *buddy* said they had *learned more* about the client during the exercises than in the previous week living together. The feedback from this pilot test illustrated that the interactions with the SMK served to enhance the sharing of personal stories between client and buddy, getting to know one another better, whilst revealing meaningful autobiographical insights from the clients to the clinician.

The Molecules That Matter.

Storytelling + Smell - Memory Kit
Mistral Rehabilitation Clinic

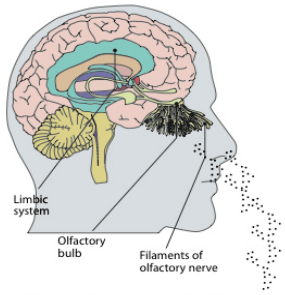
G-Motiv CRISP project
Designed by: Susana Cámara Leret
With: International Flavours & Fragrances

Why Smell?

The olfactory system is linked to the primitive region of the brain called the limbic system, which deals with emotion, motivation and association of emotions with memory.

Smell - Memory
Smell can bring back vivid memories from past experiences and when you smell something, your emotional response preceedes your understanding of what it is.

Storytelling
Because smells are familiar, pleasant or puzzling, they motivate you to share your experience with others. This exchange creates a sheltered context to share past experiences.



The anatomy of smell-memory

"Smelling makes you want to talk!"
Berend Hofman
(Mistral, 2013)

How to Smell?

1.
Smell with your eyes closed. Bring the smell to your nose slowly as you smell, some might be stronger than others!

2.
Avoid holding the smell against your nose as some smells might be stronger than others!

3.
Move the bottle left to right under your nostrils - we smell differently in each one!

4.
If your nose gets saturated, rub and smell some coffee beans or smell the inside of your elbow to recalibrate your nose.

Guidelines
- The exercises are done during the intake conversation, between the patient and their future Mistral buddy.
- At least one clinician will supervise the exercises.
- Choose a well-ventilated, private and quiet space.
- Sit with sufficient room.

Materials
- Large blank piece of paper per person smelling.
- Markers / pencils to write or draw for each person.

Participants should
- Focus on their personal experience.
- It is easy to influence what others are smelling. Avoid talking about the smells until the discussion.
- Try to consider what memories, feelings, people, places, things, etc. the smells remind you of.
- Record your first reactions to the smells - if you feel confused or disoriented that is also an experience!

Smell Exercises

Repeat these exercises for each smell:

1. Smell first, don't talk!
Ask the patient & buddy to smell, number and record the first experience (thing / memory / feeling) with the smell.

2. Tell me briefly...
Ask the patient & buddy to explain briefly their first experience with the smell.

3. Smell again...
Ask the patient & buddy to smell again, and expand on their experience with the smell.

4. OK, tell me more...
Ask the patient & buddy to smell again, and expand on their experience with the smell.

5. Share Your Stories!
Tell the patient & buddy what the smell is and talk about the personal associations to each smell. Consider what memories / places / people / things the smells remind them of. How does the smell make them feel (relaxed, tense, disoriented, etc.) and why? Discuss which smells they prefer over others and expand on the answers. What smells do you normally wear and which ones do you miss?

Remember, it's about the experience. There are NO Right / Wrong Answers!

Figure 7. Instructions manual from SMK.

The outcomes from this pilot test served to design a second design iteration of the SMK (see Figure 8), refining the graphic design of its elements, the instructions manual, and smell containers. Several versions of the final design were left at Mistral clinic for the clinicians to freely use and implement in their daily conversations with the patients. The final SMK design therefore took into consideration feedback from the use of the SMK within the clinic, highlighting the need to involve clients and clinicians within the research through design process.

RtD Phase 4: *Evaluating the Smell Memory Kit*

Procedure

The evaluation study of the Smell-Memory Kit (SMK) took place at the Orthopedagogic Center Kennemerland Het Spalier between February and July 2014, this was a different location than the Mistral clinic where the RtD took place, as the clinic was undergoing a relocation. During this period, we made independent appointments to evaluate the degree to which the SMK playfully evokes and stimulates the sharing of episodic memories, with seven client-buddy pairs (N = 14, age range 17-19) living in assisted living environments supervised by Het Spalier. As with the pilot test in Mistral clinic, at each smell session a *mentor*, consisting of a clinician or supervisory staff familiar to the clients, directed the exercises. As before, in advance of the session, the mentor received the SMK manual. The smell-playing sessions started by the mentor explaining the instructions to the clients and lasted for about 20 minutes. At least five of the eight samples had to be smelled. The smelling order of seven of the eight samples could vary as to the preferences of the clients. However, sample number eight (Vanillin) had to be smelled last, due to its medically recognised positive effects (Fox, 2009) to ensure that the exercises ended with positive associations and a pleasant experience. The sessions were observed by a student researcher, who followed the exercises to document the evoked and shared stories.

The Qualitative Results or Smell Stories

Each smell sample led to the recording of episodic memories from the seven pairs of clients from the Orthopedagogic Center Kennemerland Het Spalier. In some sessions not all eight samples were smelled. In total, the SMK led to 88 stories, 32 of which are presented in Table 1.

It has been shown that memories which are associated to odours do not require words to be elicited and that memories evoked by odours are "emotional, very clear, specific, rarely thought of and comparatively old" (Herz & Cupchik, 1992). Herz & Cupchik proposed the following set of five characteristics to describe a profile of odour-evoked memory experiences: emotionality, clarity, specificity, rarity, and age. Despite the use

Figure 8. Final design of the Smell Memory Kit: The molecules that matter (a-d).

Table 1. A selection of the smell stories obtained from the SMK pilot evaluation study.

	Smell Stories
1. Ö-Terpinene	- When I was bicycling among the {war} bunkers, my clothes smelled like this. We also entered the bunkers. - A herb garden. We used to have a garden attached to the forest. I did not went for a walk so often. - Foot fungus I have/had. - Hospital smell. I was at the EH {first aid} with my roommate a few weeks ago. And with the heart attack of my grandfather and with my uncle's appendix infection.
2. Beta Pinene	- Forest. Forest in the south of france. It makes me very happy. - A tree trunk. A while ago, I walk walking outside with Anthony, then there was a smell which reminded me of Turkey. - My mother's hair shampoo has such an extreme sweet smell. - Yes, lemons. Limoncello! In Italy I was 'on' Limoncello with my mum.
3. Methyl Mercaptan	- The polderrun! Where you run through the fields and ditches. I think that is fun. - Shit. At the latest festival I attended, such a guy said, you should go to that toilet, that one is clean. But man! It was full {of shit}. - The diapers of my little sisters. I have to change them soon again. - The smelly feet scent of my shower.
4. Dimethyl Sulfide	- The wrong apple sauce. In our back garden was an apple tree and you played among the fallen apples. - I said: grandma, you make nice food but this tomatospa {sparkling?} is really disgusting. It really wasn't good anymore. - Picnic. It smells of kisses and rose leaves. I like to eat a breadroll when I'm eating outside. - {I} smell the foul smelling kale of home. I used to complain about it and always got into an argument with my mother.
5. Dimethyl Trisulfide	- B brand of lubricating/massage oil. I played with it when I was a child. I mixed all kinds of different oils together in a cup. - It smells like sex or like food beyond perishable date…I'd like to spray some perfume. - When I had my laundry stayed too long in the washing machine. Happened to me last week again. - Gunpowder. Once a negro aimed a gun at our car and threw knifes. I'm still afraid of negroes. And my father never wanted to say what happened {back then}.
6. Methyl Anthranilate	- Perfume for old people. I never lived with my real parents, but had such a fake grandma who hugs you to death…{lol}. - My grandma's bones were breaking down. She had a kind of vaseline with mint for it. She was nice, but passed away. - A warm night. When you are having a cold and can't sleep. The stuff they spread on you then. - Previously, I went to Spain 6 times a year. The house of my grandfather. The cleaning products they used for the bathroom used to smell like this.
7. Geosmin	- When I crossed the meadow. I like to be outside, it gives me a healthy feeling. - As a child I rolled myself through the autumn leaves. - Like fungus in a barn for at least 20 years. Very musty. - The floor cloth bucket in the hallway. That smell is still there.
8. Vanillin	- Hungary. A house of my step parents. A smell of Thermen {health bath resort}. The first time I saw a women with fake tits since they were floating on the water. - Vanilla! When I cooked pudding together with my step father. We were having a good time, normally he wasn't so friendly/cozy. - Turkish cakes. - I used to go to my grandma. Than we baked cake ourselves. And when I left she said: "I think you're getting fat myboy!."

of the SMK to stimulate the recollection of episodic memories, we did not want to disrupt the story telling process, but rather allow the clients to *socially play* with the smells. Asking the clients to categorise them would have broken the narrative flow and interaction. We therefore first let the stories emerge and later categorized the stories ourselves according to the aforementioned story characteristics for an overview of the variety of stories evoked. Categorisation was performed on the appearance of explicit verbal words present in the transcribed memories by the student researcher–e.g., the emotional classification followed the explicit use of emotion descriptors such as emotional adjectives (e.g., happy, afraid, etc.) contained in the transcription of the memory. Since the clients were not asked on the rarity of the memories, we did not include this category. This resulted in the following four smell-evoked story qualities:

1. **Emotionality. Neutral or Ambiguity**: either due to the neutral effect of the sample, or due to the lack of information in the record. In some cases the smell is simply linked to food-related substances (e.g., vanilla, baklava, etc.) without any further description on the reaction of the client; **Positive or pleasant memory**: Interestingly, some smells can account for both positive and negative memories, due to mixed recollections. For this particular target group, positive odour memories were associated with activities in nature, with family members or friends, preferred foods, trips, or holidays. **Negative or unpleasant memories** were mostly purely hedonic with no further description on the memory.
2. **Clarity.** Most recollections were extremely vivid and detailed. Coinciding with the outcomes of Herz and Cupchik (1992), most memories were rated as *very clear* and *highly vivid.*

Vague recollections were described by a comparison to other things, objects, people, colours, and emotions. In some cases they were recorded as purely hedonic (e.g., recorded via an emotion descriptor). In these cases we distinguished between associations and recollected, episodic memories. **Clear**: Hospital smell. I was at the EH [First aid] with my roommate a few weeks ago. **Vague association (comparison)**: Lavender incense...or a plant, in any case nature. I see purple. Soapy, kind of nice. **Vague (purely hedonic)**: [not pleasant].

3. **Specificity.** Hereby understood relationally as a definition of place, being: "an entanglement of persons, things, trajectories, sensations, discourses and more" (Pink, 2009, p. 48). In this respect, specificity can consist of self-referential accounts as well as associations to inanimate objects or things. **Self-referential:** Foot fungus I have had. **Things, objects or animals**: Smell of a staircase/Canned olives/vanilla. Similarly, specificity can also denote rituals that unfold in relation to specific locations or others (family, friends, specific person, etc.), denoting cultural practices, cultural heritage (e.g., culinary traditions), social beliefs, and social identity linked to a socio-cultural background or family structure such as: **Cultural practices**: The polderrun! Where you run through the fields and ditches/Sewage system. The fish seller at the market dumps their waste in the street drains. **Socio cultural beliefs (heritage)**: I said grandma you make nice food but this tomato spa [sauce] is really disgusting. The smell of apple sauce, a bread roll or *broodje*, corn eaten at a bbq, tomato spa, etc. I like to eat a broodje (breadroll) when I'm eating outside. **Places**: Hungary, a house of my step parents and the smell of Thermen, a health bath resort. This was the first time I saw a woman with fake breasts since they were floating on the water. As a punishment I had to sit on the stairs. Sometime my grandma forgot me there! One afternoon, making pancakes with my mother, which we did rarely.
4. **Age.** Although we did not ask when the memory took place, the descriptive accounts alluded to memories from the early childhood and/or teens, with some memories from more recent life experiences. This correlates with recent studies on the ability of odours to cue very old episodic memories (Herz, 2004). **Old**: A herb garden. We used to have a garden attached to the forest. I did not go for a walk so often. **Recent**: A tree trunk. A while ago, I was walking outside with Anthony, then there was a smell which reminded me of Turkey. **Unknown**: As we did not ask the clients about the age of their memories, with some stories age was unknown.

Table 2 presents an overview of the frequencies of the smell-evoked story characteristics, ordered according to the eight SMK smells. As to emotionality, the results showed that most stories were ambiguous, recorded as a descriptive recollection and without specifying a positive or negative emotional arousal (e.g., when I was bicycling through the bunkers my clothes smelled like this). Overall, the smells used led to an equal distribution of positive and negative emotions. With regard to clarity, the SMK generated clear memories. The specificity of the memories was dominantly related to things, objects, or animals. References to social cultural beliefs were sparse. Age of memories seemed equally distributed from recent to old.

Table 2. The classified stories of the 7 client and buddy (c+b) pairs from the SMK evaluation, where almost all smell related stories contained things, places, family relations, cultural practices, and ambiguous emotions, being in their majority self-referential and clear stories. Furthermore, positive and negative emotions as well as old and recent age (of the memory) seem to be balanced by the SMK.

	Categories														
	Emotionality			Clarity			Specificity						Age		
	AMBIGUITY	POSITIVE	NEGATIVE	CLEAR	VAGUE (ASSOC.)	VAGUE (HEDONIC)	SELF-REFERENTIAL	THINGS, OBJECTS, ANIMALS	CULTURAL PRACTICES	SOCIO CULTURAL BELIEFS	PLACES	FAMILY / OTHERS (SOCIAL IDENTITY)	OLD	(UNKNOWN)	RECENT
1. Ö-Terpinene	10	0	2	10	3	1	6	10	4	0	6	3	4	4	3
2. Beta Pinene	7	1	0	5	3	0	4	8	3	0	3	4	1	6	1
3. Methyl Mercaptan	6	2	4	8	3	2	7	11	8	1	8	4	2	5	5
4. Dimethyl Sulfide	6	1	3	7	2	0	5	8	6	0	3	5	2	6	1
5. Dimethyl Trisulfide	4	0	1	4	1	0	2	4	2	1	0	3	1	2	2
6. Methyl Anthranilate	7	5	5	11	1	2	9	11	10	2	7	8	6	6	1
7. Geosmin	7	6	3	11	3	0	8	11	11	1	12	7	6	5	4
8. Vanillin	6	7	3	12	3	1	7	13	10	1	2	6	4	6	2
TOTAL	53	22	21	68	37	6	48	76	54	6	41	40	26	40	19

Discussion of the Evaluation Study

The results from our qualitative evaluation of the SMK indicate significant story sharing between clients from playfully evoking rich episodic memories. The SMK evaluation was designed to stimulate this exchange of stories and not primarily intended for the categorisation of the smell memories. Because of this aim, our results consist of a collection of the shared stories yet are limited since we did not ask the clients to classify them as this would have disrupted the story flow. We thus transcribed the stories according to the role of smells as *sense data*, to later encode practices and experiences, following the main odour-memory categorisations used by Herz and Cupchik (1992). The observational nature of our evaluation procedure on playful interaction with the SMK implies that we might have missed certain characteristics of the stories, such as age (e.g., how old was the memory elicited) or rarity (e.g., how often did they recall the event).

The SMK evaluation evoked a balanced amount of positive and negative memories. Nonetheless, in reviewing these outcomes, we highlight that the results are based on written transcripts from the (sometimes verbalised) emotional recollections, recorded by the student researcher during the study. Due to a lack of other recordings (e.g., audio-recordings or video footage), the valence of the recollections can therefore only be partially analysed through accompanying notes from the student researcher present during the story sharing (e.g., grief, fears, disgust, etc.). For example, unpleasant memories were identified by the student researchers as those which the clients did not feel comfortable in sharing. Thus, the molecule Dimethyl Trisulfide, found in the smell of city gas, reminded a client of gunpowder, triggering negative emotions and was recorded as an unpleasant memory: "Gunpowder. Once a *negro* aimed a gun at our car and threw knifes. I'm still afraid of *negroes*. And my father never wanted to say what happened [back then]" . In these instances, the mentor was either instructed to ask the client to state whether the memory was positive or negative, or to share more about the memory, to which the client would answer negatively. Because of this, we would like to note that a professional caretaker is needed in using the SMK, to prevent unwanted trauma sharing and manage the recollection of harmful memories. Moreover, the smell-story cited above illustrates how smell-memory can reveal repressed or unspoken past traumas that might be at the core of social/racial stigmatisation and discrimination practices. This warrants further research and is outside the scope of this paper.

General Discussion

The outcomes of the research through design are promising in depicting the use of smells as *sense data* to effectively encode practices and experiences which can later be retrieved as simulations through an encounter/exposure to an odour, reinforcing social coherence. Such use of smells to create sites of embodied knowledge can facilitate a means of bringing the past back into the present. In the context of addiction therapy, smells can be used as retrieval cues to target past traumas or harmful memories related to substance abuse. This calls for future collaborations between smell experts and healthcare professionals to further expand on the possibilities of positive smell conditioning. Acknowledging the value of patient experience, as opposed to a disembodied treatment within therapy, moreover suggests the potential of integrating smell design within care.

With regard to persuasive game design, the present study shows that smells can function as game elements eliciting and motivating the sharing of rich multimodal memories. The real-world context that makes addiction care clients refrain from sharing their personal stories seems to be changed to a more free and engaging game world. The abstract smells in the SMK transport the clients into a game-like world experience in which they feel challenged to find the matching smell-memory, whilst reacting to each other's memories. This relates to the persuasive core of smell-recollection. The SMK allows clients to move beyond the pleasant/unpleasant experience of smell to openly discuss their autobiographical memories. When an odour is encountered, it is impossible to predict which experience will follow. In this respect, smells might give rise to unwanted, shameful, or painful memories that can be harmful for the (at that moment) vulnerable care client. This has ethical implications for the use of the SMK, demanding an experienced and qualified care-professional in the role of controlling the use of the SMK and in directing the smell exercises.

The unpredictability of the smell memory experience (e.g., you cannot foresee what the smell will remind you of) makes it abstract and open, representing an engagement with uncertainty for the client. Simultaneously, the recollected memory represents a *matter of fact*, due to its reliability in a lived, past experience. Such duality of smell-memory creates a sheltering context, encouraging patients to openly share their smell stories as the smells become the *subjec*t of the conversation. Smells therefore create an intermediary space, situated between the immediate, physical sensation of the odour and the emotional recollection of a person, time, or place. The olfactory experience becomes a means of experiencing simulated, hypothetical scenarios through an imagined and embodied associative place, triggered by a smell molecule. This use of smell to investigate sensorial embodied practices therefore offers many opportunities for future design research, for example in coping with risk and uncertainty within addiction care.

Stimulating the sharing of personal stories, the value of the SMK therefore resides in *the moment of exchange* and the experience of smelling. Considering smells as sites of embodied experiences, the sharing of stories becomes simultaneously the sharing of *places*, investigating forms of intimacy through these situated exchanges in the present. This embodied practice of sensory imagining, moreover, constitutes a learning process, as it implies an ability to negotiate new meanings. Aside from encoding past experiences and practices, smells could thus also be used to create new memories through their associative power. Future sensory design research should expand on this found potential of smells as motivators for story eliciting, sharing, and generating.

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