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KEYWORDS: Linseed oil, linseed varnish, maintenance, heritage painting, painting craft, painting skills, practice, profiling, perception, repertory grid method, principal component analysis, material vocabulary, sensory quality assessments, quality control.

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Using Profiling Methods to Develop the Sensory Vocabulary of Architectural Painters Who Use Linseed Oils

By Arja Källbom

INTRODUCTION

This text exemplifies why and how the craft competence of architectural painters and paint-makers is important. It also describes how sensory profiling methods could be used in craft research in order to stimulate increased craft competence, communication, and education.

During the last half of the twentieth century, most of the traditional architectural paint binders (a crucial ingredient of the paint), such as linseed oils and vegetable and animal glues, were substituted by modern materials such as alkyds, latex, and other petrochemical products (Johansson 2001; 2004; Karlsdotter Lyckman 2005; Fridell Anter, Svedmyr, and Wannfors 2010; Standeven 2011). Over several decades, the common craft competence in relation to painting materials and procedures depleted as a direct result. Many of the older, traditional paint binders have been actualised again, since they are renewable, non-poisonous, and resource saving. Correctly used, the linseed oil paints provide beneficial results in terms of aesthetics, adhesion, and maintainability. Linseed oils and paints are needed for the preservation and maintenance of architectural and industrial heritage for painting and/or protecting buildings, structures, and artefacts with high demands on authenticity according to the Nara document of 1994. Examples of such objects are shown in Figures 1 and 2.

In order to redevelop and regain lost knowledge of how to make linseed oil paints which are similar in properties to those paints made before approximately 1930, the characters of refined linseed oils for paint-making, in terms of their chemical and physical properties, are important issues. The quality of the oils and regained linseed oil paints also need to be viewed from the perspective of craft practitioners.

Figure 1: Sikfors railway bridge in Sweden, built in 1912, presents an example of steel structures that need anticorrosive paint treatments. Photograph by Sven-Olof Ahlberg.

Binder and paint properties—such as the film-forming capacity, the drying time, and the body—are important features of paint. High film-forming capacity includes properties such as film elasticity, film hardness, weathering resistance, and the gloss of the oil or paint film. It is also relevant to discuss the liquid linseed oil's colour, clarity/turbidity, smell, viscosity and body, and its emulsifying or wetting capacity since these properties influence their usefulness for different applications. These types of properties were evaluated by the traditional painters and paint-makers before the shift to modern materials after the Second World War (Karlsdotter Lyckman 2005). Today, the characteristics of the materials and the sensory experiences related to them are seldom expressed in discussions with other craft practitioners. Sensory vocabularies could provide a quick referencing tool for painting professionals to check and control the quality of linseed oils, in order to assist in choosing the right oil for a particular purpose. A sensory vocabulary describing linseed oils can be initiated by descriptive methods, and further tested and developed in practice by painting professionals. It presents

Figure 2: A nineteenth-century railway bridge at Björneborg, Sweden. How can we take care of this heritage when the nature of the authentic painting materials has changed and few paintaers have the appropriate skills to use linseed oil paints? This issue requires communication about the interaction of tangible and intangible elements of materials and working procedures. Photograph by Sven-Olof Ahlberg.

a way to increase their so-called *competence space* and provides an opportunity to obtain and develop their craft knowledge (Sjömar 2017, 85). This will also allow for an exploration of the intangible heritage associated with the use and making of linseed oil paint, and an involvement of the paint craft practitioner's knowledge in the process of developing and documenting evidence-based treatment procedures. Ultimately, this will lead to the improved management of architectural heritage objects.

The food and beverage industry, and related research fields such as sensory profiling, utilise a large variety of methods and panellists (Murray, Delahunty, and Baxter 2001). Methods include consumers' or professionals' profiling of products for communication and product development by creating vocabularies[1] (Swahn et al. 2010; Larssen, Monteleone, and Hersleth 2018). In the food industry it is common to use expert panels who are trained in articulating their perception in consensus (Liu et al. 2018, 899). The training of the professional panels is very costly, and the experts become skilled in discriminating the finer details (they also need about three times longer training than novices). By using so-called free-choice profiling where the panellist can express their perception freely, consumers (novices) create their own vocabularies for describing products, without prior consensus or need to describe exact meaning (Guàrdia et al. 2010, 148). Investigations have shown good results when new panels create initial vocabularies themselves and refine them with increasing experience of using them (Murray, Delahunty, and Baxter 2001). In this chapter, several methods from the field of sensory studies were used for defining the basic sensory vocabulary regarding olfaction, and haptic and visual properties of refined linseed oils for architectural paint-making purposes. The research methods and research design in this study are new for craft research, and the interdisciplinarity strengthens the credibility and rigour-relevance of this work.

Observing and constantly interacting with the material (the linseed oils or paints and the substrates) could be considered as an art of or process of correspondence (Ingold 2013, 30–31; 2018, 162; Kuijpers 2018, 881–86). To have skills is to recognise and respond (and to be responded to) by the affordances that the materials offer. This is a vital aspect of making with different possible results. This led to a close understanding of the materials associated with the craft practice. Ingold refers to skills as the initiation of all knowledge, and the words connected to skills as "among our most treasured possessions" (Ingold 2018, 161). Kuijpers suggests that the interaction of skills, materials, and making is an integral part of cognitive practice (Kuijpers 2019, 609). The use of "Perception Categories" is a research design that sorts material qualities, behaviour, and performance in order to systematically explore properties that are relevant to craft practitioners or craft research (Kuijpers 2018, 867; 2019, 612.) Material knowledge described from a craft point of view is similar to the knowledge that material science describes, but differently. These aspects are also relevant to this study, where this insider's perspective is highlighted.

The aim of this chapter is to describe the process, results, and experiences of developing a basic sensory vocabulary for linseed oils. The research questions are: *How do painter professionals express their sensory experiences of different refined linseed oils? Is it possible to distinguish between different oil categories or properties by their sensorial attributes?*

CRAFT RESEARCH

This craft research is conducted at Gothenburg University in the Department of Conservation. Craft research is characterised by exploring research questions *in*, *about*, and *through* tangible and intangible aspects of crafts by the craft practitioners themselves. The craft practitioner who is studying a craft can be both subject and object and has the craft skill and competence, which are conditions for performing and explaining the procedures of the craft (Sjömar 2017, 85, 93, 102). In this study, craft practitioners are information sources that generate data through their perception and experience of their painting material. The research setting, the data collection/generation, and the interpretation are made by the author, who is also a painting craft practitioner.

The research questions in this study and in my PhD thesis are grounded in my experience as a traditional architectural painter and building conservator, self-employed for approximately 15 years, working with the preservation and restoration of heritage paintings. I usually work with listed buildings, or other public or private house stakeholders. My task involves making and using paints of different types. Attending a sensorial profiling in Örebro University at the School of Hospitality Culinary Arts and Meal Science made me interested in how sensorial experiences of different food stuff and beverages could be recorded and evaluated. This occasion was really the starting point for me becoming increasingly conscious about the odours that we are surrounded by. A dialogue started with Örebro University about whether the sensory profiling methods were also suitable for painting materials such as linseed oils.

HUMAN PERCEPTION SYSTEMS

How the human perceptions system actually works, with the entire human organism, body and mind interacting with the environment, is in strong contrast to the Western world myth of dualism between body and mind (Ingold 2011, 258). In a revolutionary book by James Gibson, *The Senses Considered as Perceptual Systems* (1966), the author reshapes the view of how our perceptions work (overviewed by, for instance, Carello and Turvey 2017; Charles 2017; Covarrubias et al. 2017a; 2017b). Gibson points out that *having sensations* is not the same thing as to *sense or to obtain perception*. Perceptual experience is something we *do* and it is a process through which an individual can become aware of the world, and to get information via active and qualitative interpretation about lived experiences (Gibson 1966, 1; Noë 2004, 1). Collecting information occurs by analysing the constant energy fluxes in the surroundings in the forms of vibrations, reflected or emitted light, and chemical emissions from objects, events, surfaces, pictures, terrain, and other animals (Gibson 1966, 7 ff.). Our senses are active and conscious (not passive or unconscious), interrelated (not mutually exclusive) systems (not channels), and work as perception systems (ibid., 47). How humans perceive information depends on our acts of looking, listening, smelling, tasting, touching, and feeling (etc.) (ibid., 268). This depends on how we have learned to perceive our presence and expectations, receptors, language, and illusions (ibid., 266). Humans continue to learn throughout their lifetimes through attention and associative learning and the use of mental imagery (Gibson 1966, 266; Barsalou 1999, 585). Humans continue to develop the nerve system and cognitive capacity throughout their entire lives (Gibson 1966, 266 ff.; Barsalou 1999, 585; Palmiero, Di Matteo, and Belardinelli 2014, 144).

Haptic Perception

The term *haptic* derives from Greek and refers to "the ability to hold on" (Gibson 1966, 97 ff.). In ordinary speech, haptic is often called *tactile touch* (without body movements). Using haptic perception, it is possible to receive active information about the environment through literal and physical contact with the body, with skin, joints and bones, by grasping and moving with the hand; dynamic touch/actions of rubbing, scraping, rolling, brushing, or motions of depression/torsion or traction of skin, in combination with other organs, such as the mouth or eyes (ibid., 134). Characteristics of surfaces, materials, and tools can be investigated with hands acting in both performatory and exploratory ways. Features such as the geometry of the object (shape, dimensions, proportions, slopes, edges, size, etc.), surface properties (texture, surface profile), or material consistency (relative temperature, shape, weight, softness, rigidity, elasticity, viscosity) could be assessed (ibid., 274). The haptic perception strongly interacts with vision, and the sensory attributes are often visionary (Dagman, Karlsson, and Wikström 2010, 15–16). When people are forced to verbalise their haptic perception, they are usually able to do so, but with initial difficulty. Active haptic perception is an everyday activity, but the experiences are rarely discussed with others, and therefore the language is underdeveloped, just as is the case for odours.

Odour Perception

The fact that humans are strongly visual creatures has led to the stimulation of language for describing colour perception in contrast to, for instance, odour perception (Zucco, Herz, and Schaal 2012, 8). For a long time, a myth has been nurtured that the human sense of smell is very underdeveloped (McGann 2017). The work of McGann (2017) and Keller and Vosshall (2016) shattered this myth by conducting extensive tests and calculating the combinations of perceptions. It has been shown that humans are capable of distinguishing about one trillion different odours, and even follow scent trails through dog-like behaviour (McGann 2017, 3). Humans recognise odours that we have sensed for only three seconds (Zucco, Herz, and Schaal 2012, 96). We are surrounded by smells—that is, gaseous compounds in relatively low concentrations that we are usually not aware of (Zucco, Herz, and Schaal 2012, 7; Young

2016, 529). In real life we track, locate, recognise, and secure odour sources, maintaining our needs in an ever-changing environment (Zucco, Herz, and Schaal 2012, 118). Ferdenzi et al. (2013) have investigated the influence on gender and culture on olfactory responses and reported differences in perceptions for men and women.

Visual Perception

Vision is our superior stimulus (Gibson 1966, 154 ff.; Young 2016, 520). The visual perceptual system is connected to our balance organs and dominates over performatory skills (Gibson 1966, 36). Sensor motorial skills are important features for seeing; seeing requires action in movement (Noë 2008, 663). This means that we must have an understanding about how stimuli change by the way we move and look, because what we see does not make sense unless we actively interpret what we see by referring to our earlier experiences (Noë 2004). For instance, we have learned how things look or how they are, and how to accept perspectives, illusions, or after-pictures (Gibson 1966, 289; Noë 2008, 665). In the craft of painting, vision interacts with all other perception systems for perceiving critical features, distinctive variations, and textures of substrate and paint materials.

RESEARCH DESIGN, METHODS, AND PROFILED MATERIALS

The research methods are focused on making the professional painters' perception explicit, systematically organised, and analysed. Overall, this means processing and interpreting of qualitative data (words) aided by semantic and conceptual codes versus frequency. The data-collecting sessions were executed on different occasions in the participants' workshops. Figure 3 shows the three main sections of the research study.

Part 1: Olfactory Profiling

The research design uses an interviewing technique of free descriptive profiling by the Repertory Grid Method (RGM), semantic raw data sorting and coding, with statistical correlation method, i.e., Principal Component Analysis (PCA). The formulation of the database has been designed before the first profiling session. The raw data is reported online to the database by each panellist during the profiling session, and extracted by the craft and sensory researchers during the data processing and analysis step. Mean values, standard deviations, and variances of attributes and intensities for each linseed oil are calculated after the semantic sorting and processed during the PCA. The olfactory profiling has earlier been reported in detail by Källbom, Nielsen and Örström, 2018.

Part 2: Haptic and Visual Profiling

The research design uses an interviewing technique by free descriptive profiling (without intensity scaling), reported online to the database by each panellist during the profiling session, and extracted during the data processing and analysis step. The attributes are semantically sorted and coded, and their frequency is plotted in Excel for each linseed oil.

Part 3: Post-Evaluation

The research design uses post-evaluation of the sensory profiling in Parts 1 and 2 by interviewing the panellists about their experiences some weeks after the sensory profiling sessions. The panellists respond to an open-ended questionnaire through Eyequestion. They respond freely and according to a 1–10 difficulty scale (10 is experienced as "most difficult"). The data is then extracted from the da-

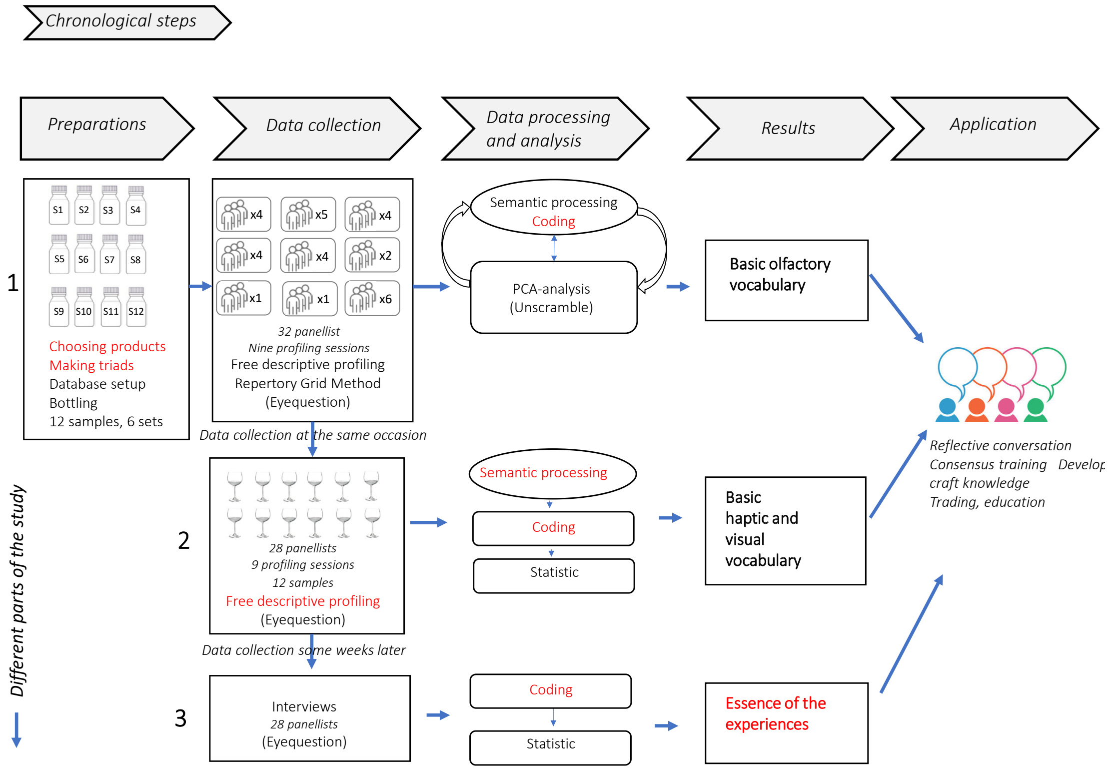

Figure 3: A model of the research study design. Red text in the figure indicates craft knowledge inputs by me, as the craft researcher. I also participated in all of the activities. Model by Arja Källbom.

tabase and quantitative analysis of the sorted and coded data is then performed. The results from this part are not reported here.

Panellists of Painting Professionals

The voluntary research participants that smell, look at, and touch the different linseed oils consist of 32 traditional Swedish architectural painters, paint-makers, and students. There are 16 of each gender, and their ages vary between 30–72 years. They are colleagues and peers, and all are part of the painters' craft community. About 90% are self-employed. All are non-smokers and free of colds or disease during the sessions. Of the 32 panellists, 28 (including me) are considered to have professional competence and know-how in their craft fields according to the competence model of Rolf (2017, 53). Given this fact, they have an ability to control the quality of their craft/work and results by will, and to manage complex problem solving. The others are architectural paint students with lower levels of proficiency. All panellists are described as positive, focused, engaged, and seriously interested in participating in the research. Some of the panellists during the olfactory profiling can be seen in Figure 4.

Figure 4: Painting professionals as panellists in the olfactory profiling. Photograph by Arja Källbom.

Profiled Linseed Oils

There were four categories of oil chosen for profiling: raw (unheated) oils, low-temperature heated oils (130–150 °C with/without air-blowing), high-temperature boiled oils (ca. 250 °C), and vacuum boiled oils/standoils (280–300°C), see Figure 5. Three refined linseed oils were chosen for profiling from each of the four categories. The samples depict a variety of products available on the market for Swedish professional architectural painters and paint-makers. Some of the linseed oils are manufactured in European countries and some in Sweden. All oils are purified by the suppliers utilising various methods. No exact refinement process temperatures or holding times are known. With the exception of the raw oils, all have added driers and none of the oils contain solvents. In order to ensure the quality of the oils, all oils used are a maximum of 12 months old. The study was finished within two months at the panellists' workplaces.

	Type of linseed oil/varnish		*Type of linseed oil/varnish*
A	Raw	G	High-temperature double-boiled
B	Raw	H	High-temperature boiled
C	Raw	I	High-temperature boiled
D	Heated (marketed as "Boiled")	J	Standoil, Viscosity 2,0 Pa•s
E	Heated (marketed as "Boiled")	K	Standoil Viscosity 2,0 Pa•s
F	Heated (marketed as "Boiled")	L	Standoil, Viscosity 4,5 Pa•s

Figure 5: Profiled linseed oils and varnishes.

Research Methods

The Repertory Grid Method (RGM) was developed as a systematic one-to-one interviewing technique for explaining and rating perception in psychology tests (Kelly 1955). The method facilitates the collection of individuals' response data with stimulus organised in triads. RGM is common in the food and beverage industry but is used in a wide variety of research fields. It can be used in, for instance, the development of vocabularies for different types of products, prototype development, sensory mapping, correspondence in consumer perception, and response to products (Murray, Delahunty, and Baxter 2001, 463). In this field, RGM is often used for studies with consumers—i.e., where the product end-users are panellists (for example, Swahn et al. 2010, 594).

The sensations from the linseed oils were profiled in comparison-sets of three samples (eight triads in total, see Figure 6.). In each triad, two oils are similar while one differs, making it easier to distinguish the differing profile. The panellists note their associations (i.e., attributes) through each triad, and then finally choose a maximum of their ten key sensory attributes. The attributes are reported to the database via an internet link provided by mobile phone or computer. After this, the participants are asked to sniff each oil again and to rank the expe-

Triad 1: A+ C + G	Triad 5: D + G + H
Triad 2: B + I + J	Triad 6: E + F + I
Triad 3: E + H + F	Triad 7: A+ F+ H
Triad 4: L + D + K	Triad 8: B+ K + L
Note: All oils except C and J were evaluated twice during data collection. The repetition of triads was done in order to intercept a broader series of sensory attributes and to increase the possibility of acquiring more associations and verbalisations.	

Figure 6: Triads used during the data collection in Part 1 (Källbom, Nielsen, and Öström 2018, 4).

rienced intensity of each attribute on a scale of 1–9 (with 9 marking the most intense) and to report this to the database. In order to avoid self-adaption, the olfactory sense is neutralised by self-sniffing hands or clothes. The participants are instructed not to use unspecific hedonic words such as good, bad, un/pleasant, etc. Specific items or objects are prioritised before unspecific personal words in order to increase the consistency of the descriptions (similar to Zucco, Herz, and Schaal 2012, 97). The panellists are free to take the time that they need or to take breaks in order to avoid fatigue.

The sessions were video recorded by me, the craft researcher, who also wrote a diary recording the events. Afterwards, these materials were studied and analysed by me as part of the participatory observation technique.

Each oil used for the olfactory profiling (Part 1 of the study, according to Figure 3) is stored in transparent borosilicate glass bottles of 100 ml for chemical laboratory purposes and labelled with randomised three-digit numbers. The bottles are filled up to approximately 95–98% and stored in a cool and dark place between the profiling sessions. Before each session they are acclimatised to room temperature. Each panellist has their own set of samples for sniffing (see Figure 5). In each triad the digitised bottles are served by the panellists, and the contents are sniffed repeatedly. Some panellists sniff inside the cap.

Oils for haptic and visual profilings (Part 2 of the study) are stored in transparent borosilicate glass bottles of 1000 ml and poured into red wine glasses before profiling. Bulbs with a temperature of 6500 K, 1320 Lumen, are used as complementary light sources. The participants use free descriptive profiling (without intensity ranking) to describe their experience of colour, turbidity, viscosity, and sensorial experience of each oil (see Figures 10–15). The panellist could perform the profilings in the way they wanted. The wine glasses provided the opportunity to swirl the oils and to touch the oils with glass rods. They were free to discuss with other panellists. The attributes were reported to the database Eyequestion by link. The used oils were discarded after profiling and the bottles were filled up between each profiling.

DATA ANALYSIS

The response data of Part 1 is extracted from the database and semantically sorted after conceptual meaning and the frequency of responses (≥ 5), in cooperation with a semantician, a food sensorial researcher, and me, the craft researcher. The sorting is performed into groups and further into subjects and adjectives. The sorting and coding processes are repeated approximately ten times to reduce the number of groups from 316 to 254, and then further into 29 (Swedish) odour attributes. Redundant attributes are eliminated and similar words are merged into the groups. Attributes that are too unspecific are excluded. Words that relate inclusion (i.e., hyponymy) are sorted in taxonomical lexical hierarchy (as described by Cruse 2001). All types of nuts are sorted into nuts, all types of flowers into flowers, etc. If the attribute is described as an object—a noun—that does not exist as a Swedish adjective, the noun is used in the vocabulary.

After the olfactory data sorting, the Principal Component Analysis (PCA) is carried out. PCA is a mathematical method that transforms a set of variables into a reduced number of uncorrelated variables called principal components by an orthogonal transformation (Westad et al. 2003; Hersleth et al. 2005). Systematic variations in data can be correlated between the objects (linseed oils) and the variables (sensory attributes and their variances), revealing cluster formations and patterns. The coordinates of the data are transformed into principal components (with samples on the y-axis and variables/sensory attributes on the x-axis) explaining the variance of the results in new bases of multivariate data distribution (score plots/map of samples) and the contribution and correlation of each variable (loading plots/map of variables) for observing the relative importance of each principal component and their correlation. A biplot is a combined score plot and correlation loading. The Unscrambler X, a multivariate analysis software (version 10.5) (CAMO Software, Norway), is used for PCA calculations and visualisations, conducted in cooperation with Örebro University.

After extracting the raw data in Part 2 from the database, a semantic sorting and coding of 1456 reported Swedish attributes (excluding symbols, etc.) is conducted by me, the craft researcher. Due to the more freely formulated answers, much effort was needed to code the attributes into basic semantic and conceptual groups, and to count the answering frequencies. Attributes with a frequency of ≥ 5 were included in the results. By analysing the meaning of the groupings, some main attributes are extracted and the basic vocabulary for each profiling is formed.

RESULTS

Part 1: Olfactory Profiling

The results show that different categories of linseed oils can be distinguished depending on olfactory qualities and that the sensory attributes can be correlated to the oil types. The score plot (Figure 16) shows sample categories corresponding to the different types of linseed oils. The largest difference can be seen between the standoils and the raw linseed oils (largest variance in PCA 1, i.e., the x-axis in Figure 16). There is a linear correlation between the clusters of raw linseed, the heated oils, and the high-temperature heated oils. Differences in variance can be distinguished between high-temperature heated oils compared to standoils and the high-temperature heated oils compared to raw oils.

The correlation loadings of the variables are shown in Figure 17. Sensory attributes such as *citrus fruit*, *fruity*, *sweet*, *buttery*, and *spicy* are, despite high frequency, located in the inner circle that explains 50% of the variance (and therefore the correlation to specific oils is low). This means that these attributes have been reported frequently but cannot be correlated to specific samples. They are still relevant for the basic olfactory vocabulary.

The biplot in Figure 18 shows that typical attributes for the raw oils are *mild*, *fresh*, *melon*, *grassy.* Heated oils are typically described as *sweet*, *flowery*, *buttery*, *honey*, *spicy*. The heated oils have the largest number of varying attributes and these varying attributes are sometimes similar to the attributes of the other profiled oils. The attributes of high-temperature heated oils are typically described as *nutty* or *like leather*. The standoils are associated with odours such as *solvent*, *decay*, *plastic*, *acidic*, *pungent/acrid*. Attributes such as *musty/hearty*, *earthy*, *rancid*, *bitter almond*, and *resin* may indicate

Figure 7

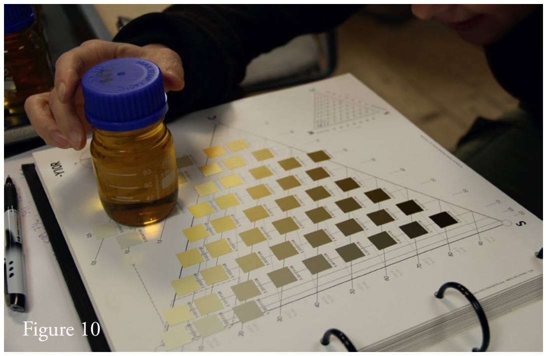
Figure 10

Figure 8

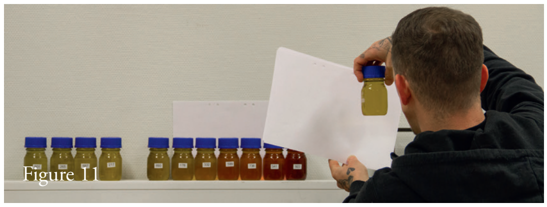
Figure 11


Figure 9


Figure 12

Figures 7–12: The linseed oils (for Part 2) in labelled wine glasses, Figure 7. The glass lids were kept on during the olfactory profiling so that the emissions from the oils would not confuse perception during the triads. During the olfactory profiling (Part 1), the oils are served in the laboratory bottles, Figure 8. After finishing all triads, the panellists chose a maximum of ten key attributes to report to the database via the internet, Figure 9. The panellists are then asked again to state the intensity (on a scale 1–9) of each attribute of each oil and report it to the database.

Examples of different ways to profile the colours of the linseed oils, Figures 10–11. The colours of the oils are actively perceived using the visual perception system by studying the reflected and transmitted visible light. In order to describe the colour, the oils (in bottles or glasses) are held against light sources, looked upon from different angles, put behind white/all reflective backgrounds, and compared in colour. The light sources and the examined oil volume affect the perception.

Turbidity is a measure of the clarity and visibility in an oil and is assessed by active looking, Figure 12. Suspended particles, or water, scatter the light and cause high turbidity—i.e., the visibility of the specific oil is low. The light sources and the examined oil volume affect the perception. The turbidity is checked by holding the oil vessel against a light source or white background and describing the light pathway through the oil in order to detect haze caused by trapped particles or gases. Photographs by Arja Källbom.

Figure 13

Figure 14

Figure 15

Figures 13–15: The viscosity of liquids describes the resistance to flow and is often referred to as the thickness of the fluid, Figure 13. High viscosity means that the liquid is thick and flowing with low velocity (or requiring higher force or temperature) when poured or running down a glass rod or swirled in a wine glass. The panellists comment on whether the oil is running or dripping off the glass rod. Some panellists used a graded scale 1–10 or 1–5, where the highest number represents the most viscous liquid. Additionally, the speed of an air bubble moving through a bottle when turning it upside down was commented on as fast, medium, or slow.

In the haptic profiling, the hand is both motor and sensor, acting in both exploratory and performatory ways, Figures 14–15. The active touch involves perceptions of complex interactions of viscosity, friction, wetting, temperature, adhesion, and tension of the oils on/between skin, muscles, and joints. The oils are rubbed, touched, smudged, pressed, lifted, etc. The amount of oil and the temperature and body of the oils affect perception. When in the hands, the mechano- and thermoreceptors cooperate with the visual system and search for characteristics. Photographs by Arja Källbom.

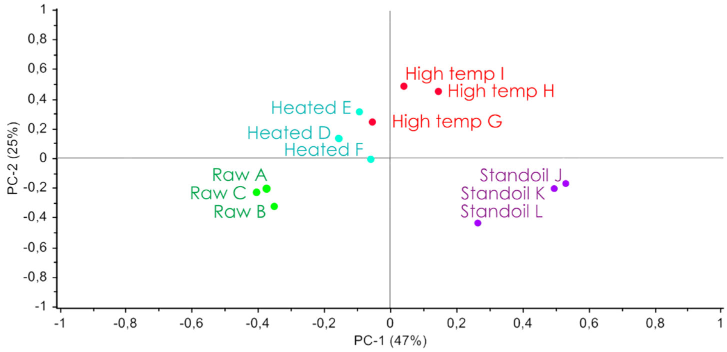

Figure 16: Score plot scores, first principal components versus the second, representing most of the variance in the data (explained variance PC1= 47%, PC2= 25%, i.e., 72%.) Data clustering can be connected to different data distributions for different types of linseed oils. (Modified from Källbom, Nielsen, Öström, 2018, 6)

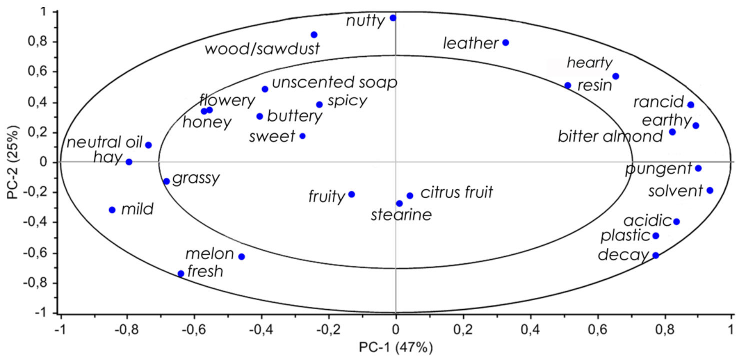

Figure 17: Correlation loadings plots from the PCA of odour quality attributes (PC1= 45%, PC2=25%) show explained variance for 50% and 100% of the results (Källbom et al. 2018, 6).

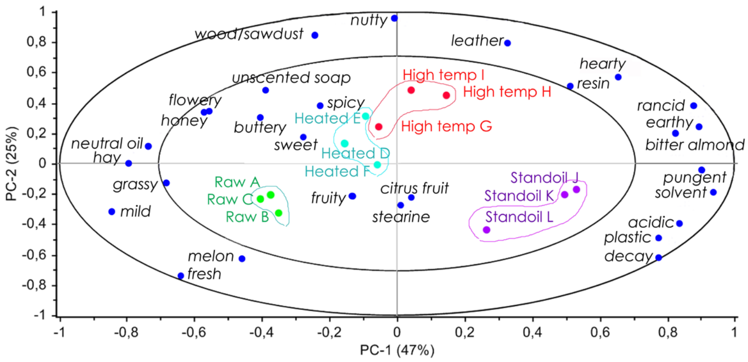

Figure 18: Biplot (score plot and correlation loadings) for PCA 1 (47%) and PCA 2 (25%). (Modified from Källbom, Nielsen, Öström, 2018, 6)

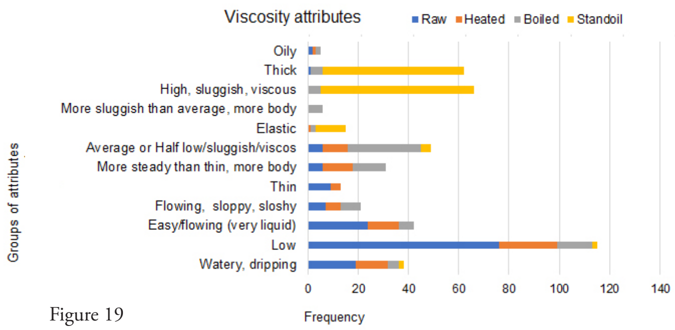

Figure 19

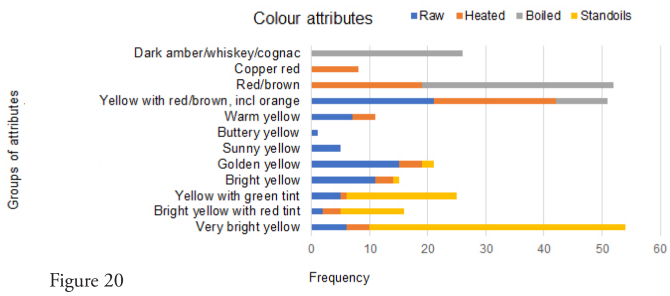

Figure 20

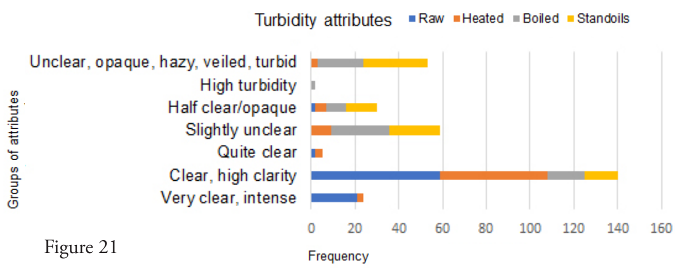

Figure 21

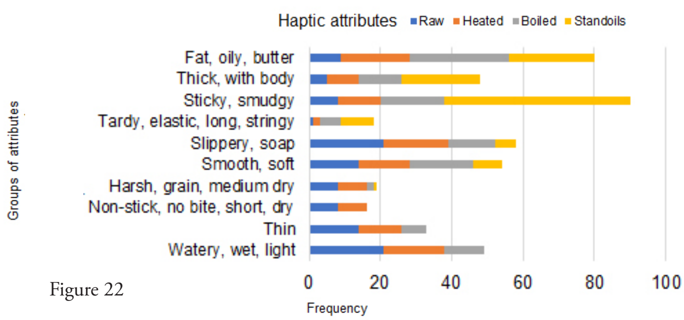

Figure 22

Figures 19–22. Frequency of visual and haptic attributes for different types of linseed oils. Note that some attributes describe approximately the same property for a type of linseed oil, like viscosity described as *watery*, *dripping*, or *low*, or *easy/flow* for raw linseed oils. This is considered when making the conclusions. Also note the differences on the scale on the x-axis.

characteristics of defect oils and are not connected to any particular group of oils. Tasting attributes such as *sweet*, *bitter*, and *acidic* indicate overlapping associative learning of tasting and smelling experiences. Differences in intensity may give differences in similar odour qualities, such as *acidic* (lower intensity) and *pungent* (higher intensity). Basic olfactory vocabulary can be seen in Figure 23. The Swedish attributes are also stated in order to reduce the risk of translation bias and to assist Nordic readers.

Part 2: Haptic and Visual Profiling

The number of categorised attributes appears to reflect the difficulties in naming the sensory perception. Easiest to profile seems to have been the properties connected to vision, such as colour (285) and turbidity (317); most difficult were the haptic properties (473) and those relating to viscosity (381). The profiling of every individual oil is summarised, and the attributes of a certain meaning are counted and categorised. The categories are formed into groups, as can be seen in Figures 19–22.

The oils' indigenous colours are described by the panellists by using colour-related adjectives, different everyday items or symbols/attributes, and the Natural Colour System (NCS). Oils with a high turbidity are more difficult to colour profile since the perceived colour is not uniform. A completely clear oil will appear as intense and deep. *Amber* is a very common symbol/attribute for colour, but since it is stated as yellow, orange, and reddish brown, as well as pale, milky, and light amber, it is difficult to use in any practical sense. Other attributes are mainly connected to transparent or semi-transparent beverages and liquids, and everyday items. It is common to associate the oils' colours to food stuffs. Very dark oils have no/limited visibility, but high turbidity is also commented on for very light yellow turbid standoils.

English odour attribute	**Swedish odour attribute**
nutty	nötig
buttery	smörig
acidic	syrlig
grassy	gräsig
decay, decomposition	förruttnelse/förmultning
earthy (cellar)	jordig (jordkällare)
mild	mild
rancid	härsken
fruity	fruktig
sweet	söt
fresh	frisk
flowery	blommig
pungent, acrid	stickande, skarp
plastic	plastig
musty, hearty	mustig, fyllig
spicy	kryddig
bitter almond	bittermandel
citrus fruit	citrusfrukt
hay	hö
resin, conifer	kåda, barrträd
timber, sawdust, wood	virke, sågspån, trä
neutral (cooking) oil, fat	neutral (mat) olja, färskt fett
stearin	stearin
melon	melon
honey	honung
solvent, chemical	lösningsmedel, kemisk
unscented soap	oparfymerad tvål
leather	läder
ocean, salt-water, shellfish	hav, saltvatten, skaldjur

Figure 23: Basic olfactory vocabulary for refined linseed oils and varnishes.

Water and *milk* are the only symbols used for describing turbidity. Haptic perception is the most difficult property to describe in Part 2. Despite the difficulties, a large number of attributes are used. There are some similarities between the reported attributes of viscosity and those of haptic experience. Symbols that are used include *water*, *oil*, *honey*, *syrup*, *treacle*, *motor oil*, *tar*, *cooking oils*. The sensory characteristics of the different types of linseed oils are seen in Figure 24. The basic haptic and visual sensory vocabulary is seen in Figure 25.

Linseed oil type	Odour	Colour	Turbidity	Viscosity	Haptic touch
Raw	Mild, fresh, melon, grassy	Bright, intense yellow	Absolutely clear	Low viscosity thin, short, dry, watery	Slippery, thin, watery, smooth
Heated	Sweet, flower, buttery, honey, spicy, leather	Orange Warm red	Clear	Low viscosity	Slippery, fat
Boiled	Nutty, leather, hearty	Dark red/brown	Slightly unclear/veiled	Average viscosity, sluggish	Sticky, smudgy, slippery, fat, oily
Standoil	Solvent, decay, plastic, acidic, pungent/acrid	Pale yellow with red or green tint	Slightly unclear Turbid	High viscosity, thick, bodied, elastic, fat	Sticky, smudgy, fat, oily, bodied

Figure 24: Characteristics of different types of linseed oils profiled in this study and Figure 6 in Källbom, Nielsen, Örström, 2018.

Main sensory attribute	***Synonyms, descriptions***
Colour	
Very bright yellow	*Very bright/pale yellow* (mycket svagt ljusgul)
(Light) yellow hue with green tint	*Yellow with weak green tint* (gul med svag grön ton, grönstick)
Bright yellow	*Sunny/golden/buttery yellow* (solgul, smörgul, guld/gyllengul), *strong, intense bright yellow, NCS Y10R* (stark, intensiv lysande klar gul ton)
Light yellow hue with red tint	*Warm yellow, dark gold* (varmgul, mörkguld), *yellow with weak red tint, NCS Y20 R* (gul med svagt röd ton)
Orange	*Reddish or brownish yellow* (gulröd/brun, orange), *orange, ~NCS Y50R*
Warm red	*Copper red* (kopparröd, brandgul, mörkt rödbrun), *intense dark orange reminding of unpatinated copper*
Dark red/brown	*Brown as whiskey or cognac, close to NCS Y70R (*mörkt rödbrun, whiskey/konjaksbrun)
Viscosity	
Low viscosity (låg viskositet)	*Watery* (vattnig), *low* (låg), *dripping* (droppig), *flowing* (rinning), *sloppy* (blaskig), *sloshy* (skvimpig)
Thin (tunn)	*Non-bodied or without body* (utan kropp)
Elastic (elastisk)	*Tough* (seg), *stringy* (trådig)
Bodied (med kropp)	*Thick* (tjock)
Oily (oljig)	*Fat* (fet)
High viscosity (hög viskositet)	*Sluggish* (trög), *viscous* (viskös), *high* (hög)
Turbidity	
Absolutely clear (helt klar)	*Very clear, clear, high clarity, low turbidity* (helt klar, låg turbiditet), *absolutely transparent, visible, high intensity, lustrous*
Clear	*Clear, high clarity* (klar, hög klarhet)
Clear with some turbidity (nästan klar)	*Clear, visible but slightly unclear/veiled/turbid* (klar men lätt grumlig/slöjig, beslöjad)
Veiled (något slöjig)	*Somewhat unclear/veiled/hazy* (halvklar, halvgrumlig), *some visibility* (något genomsiktlig)
Turbid (oklar)	*Non-transparent, opaque* (ogenomsiktlig), *turbidity* (hög grumlighet), *hazy* (simmig), *not visible* (*grumlig*)
Haptic touch	
Watery (vattnig)	*Wet* (våt), *light* (lätt)
Oily (oljig)	*Fat* (fet), *slippery* (glatt, smörjig), *soapy* (såpig), *buttery* (smörig)
Dry (torr)	*Meager* (mager)
Smooth (len)	*Soft* (mjuk), *full* (rund), *smooth* (slät)
Slippery (hal)	*Slippery* (glatt, glidig), *soapy* (såpig)
Harsh (sträv)	*Grainy* (grynig), *somewhat dry* (halvtorr)
Long (lång)	*Sticky* (klibbig), *stringy* (trådig)
Elastic (elastisk)	*Tardy* (seg), *stringy* (trådig), *gluey* (seg). *Similar to long.*
Short (kort)	*Non-sticking, without bite* (utan bett), *dry* (torr), *brittle* (spröd)
Sticky (klibbig)	*Sticky, tacky, smudgy, adhesive* (klibbig, kladdig,kletig), *gluey* (klistrig, limmig), *bite* (bett)
Biting (med bett)	*Sticky* (limmig, klistrig utan trådighet)
Thin (tunn)	*Thin* (tunn), *without body* (utan kropp)
Bodied (kropp)	*Thick* (tjock, fyllig)

Figure 25: The basic visual and haptic vocabulary based on profiled linseed oils.

DISCUSSION

To Identify and Name Sensory Perceptions

The human abilities to perceive sensations and to associate, reflect, and verbalise these experiences are basic conditions for the profiling methods. The ability to do so varies between individuals due to physiological differences, genetics, and history of life and experiences. Any act of perception includes the risk of failing to notice or the possibility of overlooking, experiencing misleading sensation illusions or sense adaptation. Acts of perception also offer great opportunities for collecting information. The research field of sensory studies deals with this by using a variety of interviewing techniques, statistical methods, and research designs to reduce the risk of bias or the panellists' fatigue.

In this study the sensory profilings indicate an increasing difficulty in identifying and naming sensory perceptions, from colour => turbidity => viscosity => touch => to odour. It is not so surprising that colour profiling was easiest to perform since vision is a strong system of perception. The panellists are painters, who assess and discuss colours on a daily basis. Turbidity profiling is similar to colour profiling. The difficulties of verbalising haptic perception are similar to the results of Dagman, Karlsson, and Wikström (2010). Odour profiling is experienced as difficult and exhausting. The panellists perceive chemical emissions by active sniffing. When the gaseous, lipophilic molecules reach the olfactory bulb in the nasal cavity, the receptors send signals to the brain (Zucco, Herz, and Schaal 2012, 101–2). The amygdala processes emotional experiences and the hippocampus processes associative learning in the brain, but the connection to language cognition areas is weak (ibid., 85). This is why it is difficult to name perceived and associated odours. The panellists are profiling the linseed oils in triads in order to make it easier to distinguish the sample that is deviating from the others.

Experiences from this study indicate that the ability to associate, recognise, and name odours can be trained in a short period. The two first triads are tough and frustrating, but after approximately 3–6 sniffs of each oil, it gets easier. After a day, the panellists are capable of ranking the oils by intensity and odour qualities, without neutralising the smelling sense between the oils. It seems that when the panellists become able to identify and name odours, they can then discriminate odours easily. This supports observations that verbalisation of odours will enhance a long-term mental imagery of the odours (Palmiero, Di Matteo, and Belardinelli 2014, 144). According to the panellists, the attentive, active interaction of haptic, visual, and olfactory perception of the refined linseed oils during the sessions gave them (embodied) memories to return back to when comparing these properties with those of other oils.

The results show that it is possible to correlate and distinguish between different categories of linseed oils (raw, heated, high-temperature heated, and standoils) and their odour qualities with PCA. It is also possible to correlate visual and haptic sensory attributes to the different types of linseed oils with the free-choice profiling method.

The results show in a pedagogic way the differences and similarities between the many variables and samples. In the haptic and visual profiling PCA was not used since the answers were given more freely and were not prechosen or ranked by intensity by the individual panellist for all of the oils, since this was a big and time-consuming task that would have led to fatigue. To avoid fatigue, a separate occasion would have been needed for the profiling session. On the other hand, the interpretation of the visual and haptic profiling was more difficult and time consuming, and also more dependent on my experiences as a painter. The correlation between the variables and the samples for visual and haptic attributes are not as clear as when PCA was used for the olfactory attributes of the linseed oils.

The use of symbols (representations) for describing sensory attributes is especially clear for odours, colours, and viscosity. These include everyday items and food-related objects. Odour attributes associated to defect materials and synthetic chemicals were also common. This confirms that familiarity to stimuli has a strong influence on semantic naming of sensory attributes, as described by Keller and Vosshall (2016, 12).

Craft Perspectives on This Research

How are the results affected by the fact that the panellists are craft professionals? The differences between trained expert panels and novices are related to the experts' higher cognitive ability and larger knowledge base (Schiefer and Fischer 2008, 347). Other studies such as those performed by Swahn et al. (2010, 612), Guàrdia et al. (2010), Bastian et al. (2008, 181), and Donadini et al. (2008, 341), confirm that the profiling made by consumers (i.e., untrained panels or novices) expresses approximately the same attributes but in a less detailed manner when compared to expert panels. The panellists of this study are to be considered as consumers of the products and end users. Still, they are novices compared to trained panels. It is probable that the panellists in this study, who are skilled in their craft but are not trained for sensory profiling, give less detailed responses than if trained panels had been used, but may still have beneficial sensory skills compared to non-painters.

However, the painting panellists contribute to the study with their use of professional praxis terms for describing sensory attributes. When there is a high level of involvement and need for a product, the efforts and quality of the profiling of consumers are affected according to Recchia, Monteleone, and Tuorila (2012, 153). The panellists' familiarities with colours, odours, touching, and looking at paint ingredients are considered as benefits for the results in this study. This has also enriched the existing vocabulary with new terms (for instance, for haptic touch) and it is valuable that the new terms and concepts come from the panellists since they are going to use them in their work. As mentioned earlier, benefits have been observed when new panels create initial vocabularies themselves and then refine them with increasing experience of using them (Murray, Delahunty, and Baxter 2001). Due to their working experiences, the panellists may have a larger smell reference library connected to linseed oils (or other drying oils) and paint ingredients in comparison to non-painter consumers. For instance, many (but not all) commercial paintmakers reacted to the odour of the linseed oils used in their own paint production. Experienced consumers have adapted over a long period of time to certain characteristic odours, and could respond differently than laymen (Recchia, Monteleone, and Tuorila 2012, 160). Painters may find the linseed oil odours less unpleasant and might be able to identify the quality and the attributes of the odour more easily.

To some extent, the participants were able to "blind" comment on, or suggest applications for, specific linseed oils, and their answers closely related to the types of applications the specific oils are actually commonly used for. Examples of a specific application would be to choose a watery raw oil without body (*mild*, *grassy* odour) for correcting absorbing substrates before painting; raw

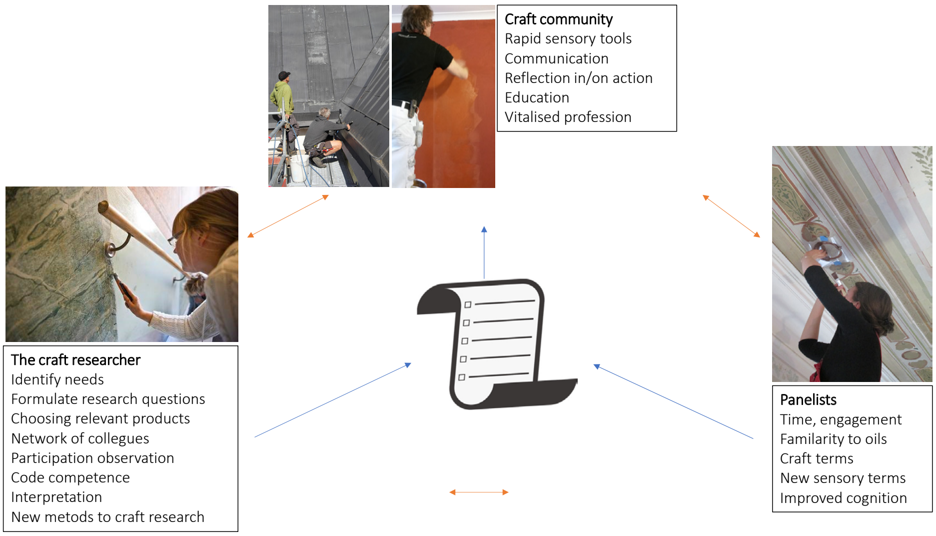

Figure 26: The craft researchers' and panellists' contributions to the basic sensory vocabulary affect individual painters and the craft community by interactions over a long period of time. Photographs by Arja Källbom.

oil or air-blown oils (*flowery*, *buttery* odour) with higher hydrophilicity are beneficial for making OW (Oil in Water) emulsion paints; fast-drying, high-temperature heated oils (with *buttery, nutty* odours) that form a glossy, elastic film are beneficial for making anticorrosive paints for outdoor use; refined fatty hydrophobic oils forming elastic and weather-resistant films (such as *pungent* standoils) could be added to top coats. The high-temperature refined linseed oils are also beneficial for indoor surfaces exposed to wear such as painted floors. The body of an oil affects the pigment wetting or the volume concentration and, therefore, the viscosity and applicability of the paint. Odour qualities such as *musty/hearty*, *earthy*, *rancid*, *bitter almond*, or *resin* may indicate features of decomposing oils, which may result in long drying times and low-quality paint films. Turbid oils could indicate rancidity due to moisture-initiated oxidation or low-quality film formation due to impurities. This could be important for making in-situ adjustments to paints depending on specific conditions.

The results depict the sensory characteristics of a number of different types of refined linseed oils available on the Swedish market and evaluated by a group of painting professionals. The need for communication of sensory attributes for different types of oils is identified by me as a craft practitioner and craft researcher. The same is valid for the formulation of the research question and the research design. The choosing of these particular linseed oils, and the grouping of these into triads, is affected by me since they are chosen due to their usage and types. As I participated in all of the profiling sessions, I also compare the proposed attributes with my perception experiences when formulating the vocabulary. An essential benefit of participation observation is to know things "from the inside," as Ingold points out (2013, 5). The semantic coding and interpretation of the attributes are also affected by my

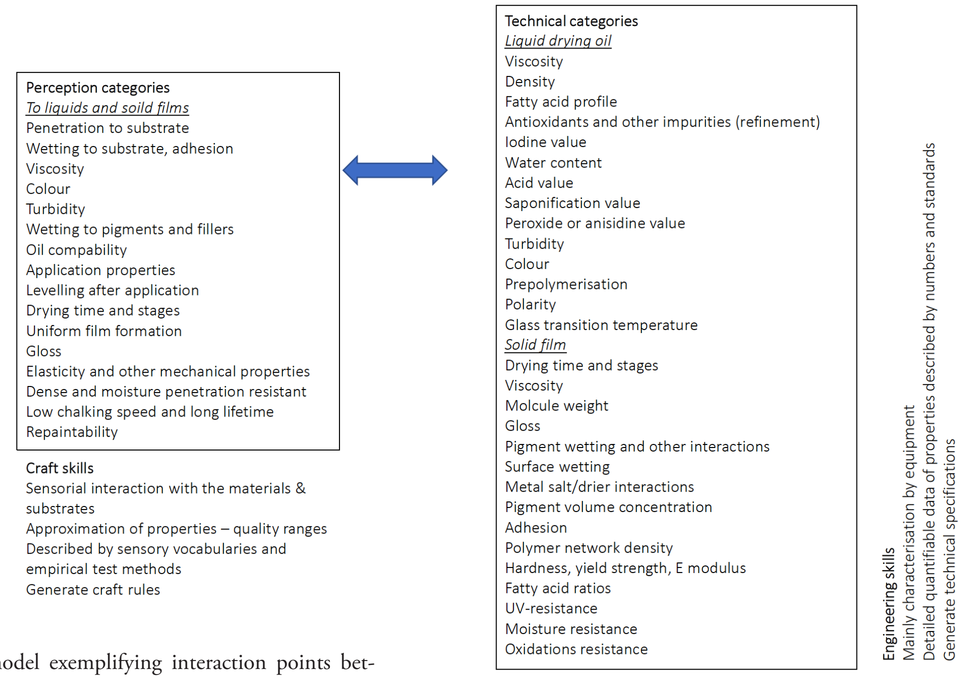

Figure 27: A model exemplifying interaction points between perception categories and technical (material science) categories for linseed oils and paints.

painting profession, since many are common craft terms. Examples of craft coding and interpretation of the attributes include describing the touch as *biting* (bett) and to know that it means that the oil has a quick and strong adhesion to the skin or substrate (almost elongating the skin), or describing the touch as *short* (kort) (almost a synonym for *dry* [torr]) to suggest that the adhesion is not so good and that elastic strings of oil are not formed between fingers when separating them. These types of distinction are probably very difficult to make for those who are not craft practitioners. This is called *code competence* and refers to hermeneutical knowledge and the ability to interpret tangible signs into the intangible (Almevik 2011, 167–68). I suggest that this is also useful for describing the meaning of craft terms and sensory expressions. Craft inputs and possible outputs of this study are visualised in Figure 26.

The sensory vocabulary will be tested further by the professionals in the process of reflective practices and conversations for improving craft knowledge and education, and the attributes are used in building a communication where the specific attributes are intertwined in the language. The profiled linseed oils are also characterised further, regarding chemical and physical properties. Relevant perception categories for linseed oils and paints could be exemplified in Figure 27, similar to Kuijpers's methodology (2018, 865–67). To this, technical categories are added and exemplified. These are attributes of the materials that could be characterised in a laboratory. Analogous to the methodology of Kuijpers, this is used to organise and analyse different types of data (Kuijpers 2018, 867). This could potentially be connected to a process chain where perception categories are added in order to visualise interactions (2018, 869, 879). As an addition, this methodology could be refined further by using reduced factorial research design experiments and the perception categories are then to be considered as variables. It

Sensory profiling and short craft description
The colour is described as *bright medium yellow with slightly red hue*, such as ~NCS Y20R" and the oil is *absolutely clear*. The odour is described as *hay-like, flowery, melon-like, fresh*. It feels *watery* and *thin* between fingers and skin and the *viscosity is low* (*waterlike*) and *sloppy* (runs easily off a glass rod). The liquid oil feels *short*, *soft*, *slippery without body* to skin. Even after long storage, no footage could be observed in the container, meaning that the oil is well purified. The oil is used as an impregnation due to its good penetration properties and ability to saturate an absorbing substrate. The drying time is five days at room temperature unless driers are added (results in drying time one-two day). This oil is used for it high cleanliess and good emulsifying capacity, for different types of tempera paints. It is not suitable for applications where a weathering resistant film is required since the paint film is normally soft (but elastic).

Technical characterisation
Density: 0,9299 g/cm 3
Refractive index: 1,4811 at 20°C
Water content: 0,05 %
Iodine value: 188
Saponification value: 189 mg KOH/g
Free fatty acid: 3,3
Acid value: 6,50 mg KOH/g
Peroxide value: 34 meq/kg
Colour(Lovibond): yellow 60,0, red 6,0, blue 0,0

Fatty acid profile:
Palmitic acid 5,3, stearic acid 3,0, oleic acid 20,5, linoleic acid 15,6, linolenic acid 54,6 %

Figure 28. Example of how a raw linseed oil is described from both a craft and a technical (material science) point of view. Photographs by Arja Källbom.

could also be used as a basis for developing not only the chain of operations on one occasion but also a repetitive cycle of painting maintenance. Figure 28 shows an example of the sensory profiling of a raw linseed oil versus some of its technical, material science properties. The difficulty is to interconnect the attributes. There is not necessarily any dichotomy to the different types to characterise the same materials, but this is not the theme of this chapter. It is interesting, however, to note that engineering skills may also include craft or sensory skills, for instance to perform and interpret experiments.

The well-established research methods and research design in this study are not novel in the field of sensory studies, but they are new for craft research. The interdisciplinary transposing strengthens the credibility and rigour-relevance of craft research and worked well for the purpose of formulating an initial, basic sensory vocabulary for linseed oils. My experience as a craft researcher is essential for defining the problem, relevance, and aim of the study. It also influenced the interpretation of the results due to my code competence. Similar methods could be used further in this topic, for instance to sensory profile drying painted surfaces or the application viscosities of paint, etc. The research design and methods used here could also be used for other crafts needing to develop sensory vocabularies for the characterisation of materials. As well as traditional paint and surface treatments, mortar, plastering and rendering, gardening, gilding, and tarring may also find the methods useful.

CONCLUSIONS

Craft knowledge is partly lost from the area of traditional architectural paint-making and refined linseed oils. Descriptive sensory research methods common in the field of food and beverage sensory studies have been used in this study for the sensory profiling of linseed oils for architectural painting and paint-making purposes. The research methods used are interviewing techniques such as the RGM, combined with statistical correlation methods (PCA) and semantic processing and coding analysis for the development of a basic olfactory vocabulary. In addition, free-choice profiling has been used to form a basic visual and haptic vocabulary. The research design has worked well for this purpose and shows great potential for further applications in the field of craft research.

The results show that it is possible to correlate sensory attributes to different types of linseed oils. Sensory attributes of the linseed oils are expressed by combining existing painting terms and newly invented terms using everyday items such as foodstuff as symbols. Sensory attributes associated with defective materials and synthetic chemicals were also common. On the basis of the results, a basic sensory vocabulary is formulated by a panel of painting professionals for a number of refined linseed oils for paint and paint-making purposes from the Swedish market. The application of the current study is to encourage individual and collective interaction between craft and paint materials by providing a basic language which can be used in order to stimulate reflective practice, communication, and education in craft knowledge associated to architectural heritage.

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ENDNOTE

1. "Vocabulary" can be defined as a body of words, characteristic of, or adjusted for, specific functions (Svenska Akademiens Ordbok [SAOB] 2017).