Workshopping the textile hand: Reimagining subjective assessment of textile materials with digital technologies

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https://doi.org/10.21606/drs.2024.536

Abstract: Designers continuously move between analog and digital spaces in order to assess sensory qualities of materials to build comprehensive references when sourcing and selecting them. Material decision making in contemporary design practice is increasingly collaborative. However, traditionally, subjective assessment of textiles has been studied at the individual level, focusing less on group workshops. This paper analyses two workshops where participants assessed sensory properties of textile materials, one individually, and one in groups, to show: 1. the difference of subjective material collection between individuals or groups. 2. improvements to the subjective assessment process, comparing physical and digital tools. 3. validation of the subjective differences among various material properties, contributing valuable insights for the assessment process in digital environments. This paper contributes references for the implementation of subjective assessments using digital platforms, ultimately improving the user experience for future designer-researcher digital tools.

Keywords: Textile Hand; digital tools; sensory properties; collaborative design

1. Introduction

Material selection is a crucial step in the design process for product, textile and fashion designers, and is developed over years of experience of working with and touching materials. Designers develop their own libraries and systems to select and source materials, which are often separate from established textile industry methods and standards for assessing pertinent textile properties, which often are technical in description. Subjective properties of materials, describing how they feel and are experienced, are embodied in developed knowledge of the designer and are difficult to convey or share with others in numeric expressions.

In an increasingly digital era, Design fields interact with digital technologies and tools more and more (Nimkulrat et al., 2016). Within textile design, which is an inherently physical interaction, whether it be through 3D simulations of materials, designing garments with AI, or using software to create patterns. However digital the design process, the majority of textile design still eventually becomes an analogue process, making physically with materials. Textile designers also still rely predominantly on physical interaction when it comes to sourcing materials. The challenge to present tactile data of textile materials through a digital platform has resulted in the neglect of digitalisation at this stage. Therefore, it is no surprise that designers still opt for visiting expos and shops physically in order to gather accurate sensory and subjective data on materials to source. This still remains challenging when trying to explain to colleagues or pass on tacit knowledge about material characteristics. This research aims to tackle these challenges and make designing with textile materials more reliable and appealing for designers transitioning from digital tools to analogue making.

Our current research focuses on improving conventional material libraries with sensory properties gathered throughout studies and AI technologies to combine, predict and relate these properties with each other. This paper describes two workshops which aim to generate new ideas on how materials' subjective and sensory properties might be presented in a sensory material library digital too. These insights from the workshops aim to bring the physical textile assessment standards into the digital era, and in the first instance give textile and fashion designers new forms of discovering, selecting and making. In the broader context of creating a digital sensory material library, our study of subjective data and its assessment process will benefit designers and manufacturers in a more holistic way. In both workshops, participants assessed textiles, rating a selection of fabrics on bipolar scales. The workshops differed in how the assessments exercises were conducted: in one, participants worked individually with physical worksheets, and in the other, participants worked in small groups with digital worksheets. In both workshops, the textile assessment exercises primed the participants for follow-on brainstorming activity, with the aim of the tactile experience to contribute to the producing insights in new ways AI and digital tools can be used in textile assessments.

Through a workshop approach, this paper presents three main contributions:

1. It validates the individual and group workshop format for subjective textile analysis and compares their advantages and disadvantages.
2. It compares various material properties in the current assessment and validates the subjective assessment content.

3. It improves the subjective assessment tools. By testing with the physical and digital tools, we present insights based on the ideation from the workshop on the subjective assessment tools and new digital tool designs.

In the next section, we provide a background on textile assessment, which is often conducted with individual material experts, and related work in conducting textile assessment in group workshops. Section 3 provides details on two workshop structures and methodology in how we had participants conduct textile assessment. Section 4 presents the results from the workshops which we analyse and discuss in Section 5. In Section 6 we synthesise the ideation results along the lines of two research highlights. Finally, Section 7 ends the paper with conclusions.

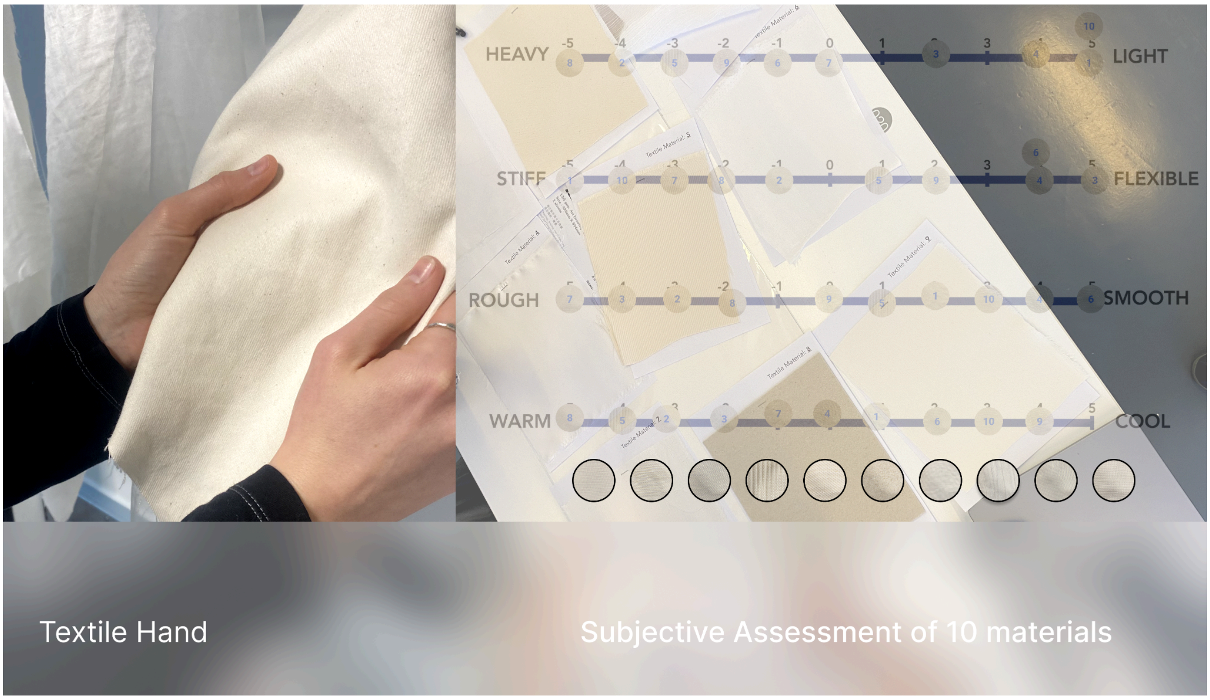

Figure 1 Subjective Assessment involves touching the textile and rating with bipolar scales.

2. Background and related work

The human perception of textiles based upon the sensory experience is very influential in which textiles are selected for use in apparel and other design applications. In the past 100 years, the *'hand'* of textiles has been studied (De Boos, 2005), standardised by industry through objective-subjective assessments (AATCC, 1990) and continues to be researched to resolve its multiple definition (Ciesielska-Wróbel & Van Langenhove, 2012). The textile 'hand' is a subjective assessment through tactile handling of a fabric (Behery, 2005) and also is described as the 'total sensation, experience when a fabric is touched or manipulated in the fingers' (Luible et al., 2007). A typical textile assessment study (Tadesse et al., 2019) utilises a panel of textile experts, of around 10-30 individuals. They evaluate textiles by standardised touching gestures, sometimes blindfolded or with the fabrics obscured without any visual cues. Each textile is rated on numerical bipolar scales, such as warm-cool, itchy-silky, sticky-slippery, rough-smooth, hard-soft, thick-thin etc…, and the scales vary from study to study, often driven by the textile application. Figure 1 shows the process of evaluating a textile through touch and the subjective scales typically used in the assessment process. The values from these ratings are often correlated with physical objective measurements of the textiles, with regression, fuzzy logic and neural network modelling approaches as in Tadesse et al. (2019). One thing that is common in this industrial standardised approach to textile assessment is that textiles are evaluated by individual experts.

Moving beyond studies that utilise the industrial standards, research into evaluating the 'hand' of textiles has been broadened to looking at the emotional aspects related to touch and feel (Petreca et al., 2015), from experts and non-experts perspectives (Soufflet et al., 2004), and establishing relationships between subjective assessments and touch gestures as measured by hand muscle activity and arm movement data (Olugbade et al., 2023).

However, one area that has been less explored is textile assessment done in a group setting, where there is a dialogue between individuals. Bang and Nissen conducted a series of studies that applied textile assessment in a group setting with future textile design students as part of one-week courses with daily studio work (Bang & Nissen, 2009). They took the Repertory Grid (RG) technique and applied it to textile analysis. RG is a psychometric tool, developed in the 1950's by George Kelley, to measure an individual's way of constructing their views of the world - of people, places and things (Kelley, 1955; Fransella et al., 2004). RG is a four step process, where first elements are selected, such as textiles, and then are compared in (random) batches of 3, or *triads*, to elicit *constructs* in a bipolar form (such as soft-rough). Then, in the third step, the elements are placed along the bipolar scale. Repeating these steps constructs a grid of elements placed along constructs, which, in the fourth step are analysed. RG classically is conducted by a trained expert interviewer and a participant interviewee, and from this technique the textile standard of subject assessment evolved from. Bang and Nissen utilised the RG technique in a small group setting, removing the expert interviewer and left the participants to establish, through collaboration and dialogue, their own methods of textile analysis by allowing them to decide on the elements, constructs and sorting through dialogue. This process is intersubjective, and was conducted over multiple days and provided the student participants with freedom to work on their own design tasks.

Within the context of design workshops, which run typically 2-4 hours in length, Atkinson et al. (2016) conducted a comparison study between non-experts groups (2-3 participants) and design experts (as individuals) (Atkinson et al. 2016). In their study, they also constrained the elements, or textile materials, to be evaluated, to be assessed on a predetermined set of bipolar constructs: rough-smooth, thick-thin, stiff-flexible and warm-cool. Where the Bang and Nissen (2009) studies evaluated their workshops through qualitative interviews, they did not conduct the analysis step on the assessment data. However, quantitative analysis was done with Atkinson et al (2016). They discovered that within the selection of materials there was good correlation between small groups of consumer participants and individual design experts, as well as physical measured properties.

Where Atkinson et al. (2016) conducted statistical analysis of the textile assessment data after the study, one might ask how the participants, in groups, might analyse or reason about the textile assessment data they collected. How does one portray the data in a meaningful way to designers? Statistical outcomes such as in Atkinson et al. (2016) provide good confidence in the textile assessment methods, but these techniques and outcomes may be difficult to convey to designers. In this paper, we look at insights from having participants brainstorm about methods to convey the textile assessment data, after experiencing subjective assessment, as groups on a set of textile materials.

3. Methodology

We conducted two workshops involving textile assessment: one through individual material assessment and one through group 'consensus' assessment. Both workshops used the same 10 textiles and utilised physical and digital tools for the participants to record their assessments. This section presents the materials, the workshop organisation, subjective assessment tool design and the ideation process as methodology.

3.1 Textile materials selection

Table 1 shows the 10 selected materials the participants assessed in the workshops. Materials of varying weights, structures, compositions and textures were selected to provide participants with a varied experience and as a result to exercise the whole length of each scale. Despite these variations, the 10 materials were also chosen as relatively standard textiles in order to have a collection of familiar feeling textiles, even to an inexperienced audience. Neutral undyed and white colours were chosen to eradicate bias of associations with tones and the scales' meanings.

Table 1 Selected workshop materials.

ID	Name	Medium	Colour	Composition	Structure	Substructure	Construction	g/m2
1	Crepe chiffon Silk	Animal	White	100% Silk	Woven	Plain	Crepe Chiffon	14
2	Silky Natural Denim Blend	Plant/ Animal	Un-dyed	55% BCI Cotton 35% TENCEL™ Fibres 10% Silk filaments	Woven	Twill	Denim	262
3	Ultra-lightweight	Plant	Ivory	100% TENCEL™ Lyocell Filament	Woven	Plain	Textured Crepe	63

	Luxury Bark Crepe							
4	Silk Tropical Twill	Animal	Ivory	100% Silk	Woven	Twill	Tropical	80
5	Rare Chunky Cord	Plant	Warm Cream	67% TENCEL™ Lyocell Fibres 33% TENCEL™ LUXE Lyocell Filament	Woven	Other	Cord	307
6	Premium Peach Satin: TENCEL™ Luxe	Plant	Ivory	70% TENCEL™ Luxe Lyocell filaments 30% TENCEL Lyocell fibres	Woven	Twill	S Twist	141
7	Coated Juniper Linen	Plant	White	100% Linen	Woven	Plain		148
8	Wool Serge Natural (Dying)	Animal	Natural Cream	100% Wool	Woven	Plain	Serge Felt	508
9	Soft Canvas Linen and TENCEL™ Lyocell Blend	Plant	Off White	52% Linen 48% TENCEL™ Lyocell	Woven	Twill	Broken Z with Slub	225
10	Polyester Organza	Synthetic	White Sparkle	100% Polyester	Woven	Plain	Organza	14

3.2 Workshop organisation

Our workshops were geared towards an audience with a background in design and involved design students and international design conference attendees (Table 2).

Table 2 The workshops' participants.

Workshop	**Individual workshop**	**Group workshop**
Number of people	25	13
Background	Design Students	Design Academics
Valid assessments	23	5

Individual Workshop. In the first workshop 25 post-graduate design students (10 males, 15 females), aged 22-26, individually evaluated the materials (of those 23 assessment sheets were validated and included in the data). All participants possessed higher academic backgrounds, holding master's degrees within fields encompassing STEM and cross-disciplinary domains closely affiliated with design.

Group Workshop. The second workshop was conducted within a design conference, 13 design academics (5 males, 8 females), representing diverse nationalities and ages, were organised into five groups of three to recreate collaborative material assessment within contemporary design practice. Each participant held academic qualifications extending to the level of a master's degree or beyond, firmly establishing their credentials within the domain of design.

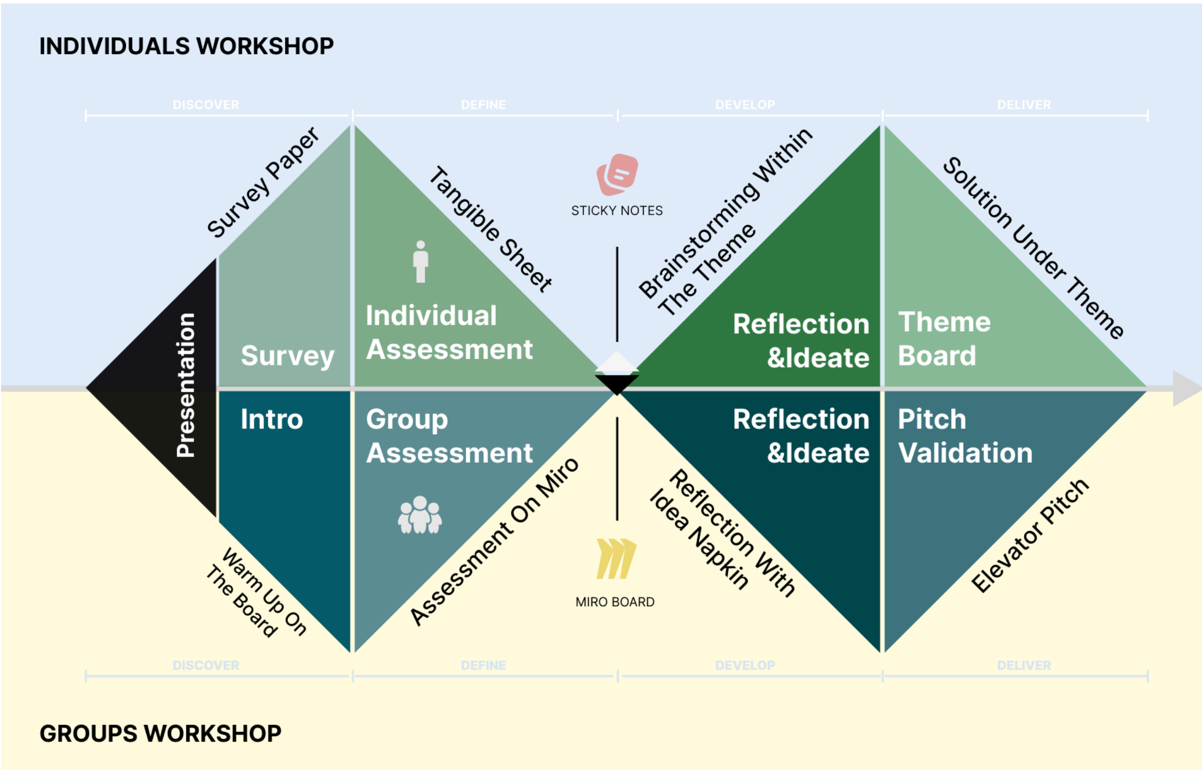

Figure 2 Double Diamond diagram of the workshops.

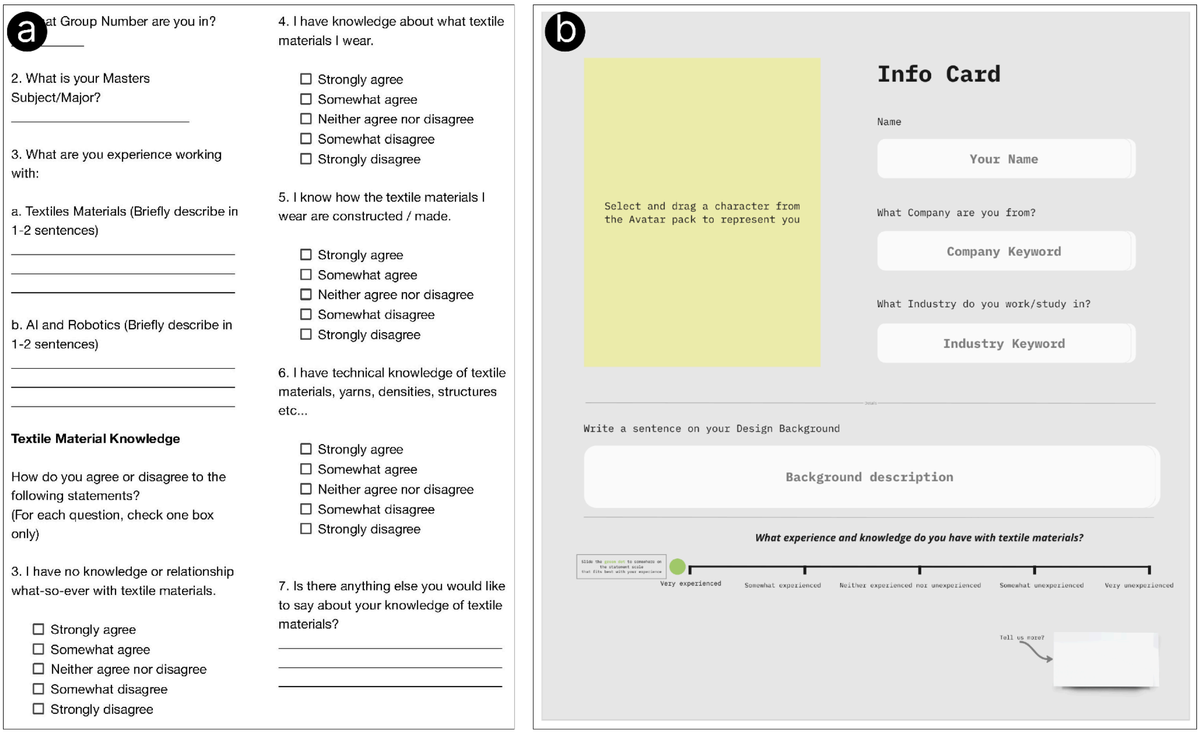

Figure 3 a. Individual paper survey, b. Group digital participant card.

Figure 2 displays the methods used in both workshops through the Double Diamond, which follows the process of *Discover*, *Define*, *Develop*, *Deliver* (Design Council, 2003).

The *Discover* stage began with a presentation introducing 'textile hand' and assessment. A paper survey (Figure 3a) was used in the Individual workshop to collate statistics on their knowledge and experience working with textile materials, where a digital participants card (Figure 3b) was used in the Group workshop to capture demographics and textile knowledge, and acted as an icebreaker exercise. A warm-up exercise followed as a hands-on material assessment tutorial utilised material 1. Initially only visually assessing the material, and then physically, writing three descriptors at both stages, this allowed participants to reflect on the importance of tactile data and the limitation of visual assessment of materials.

3.3 Subjective assessment tool design

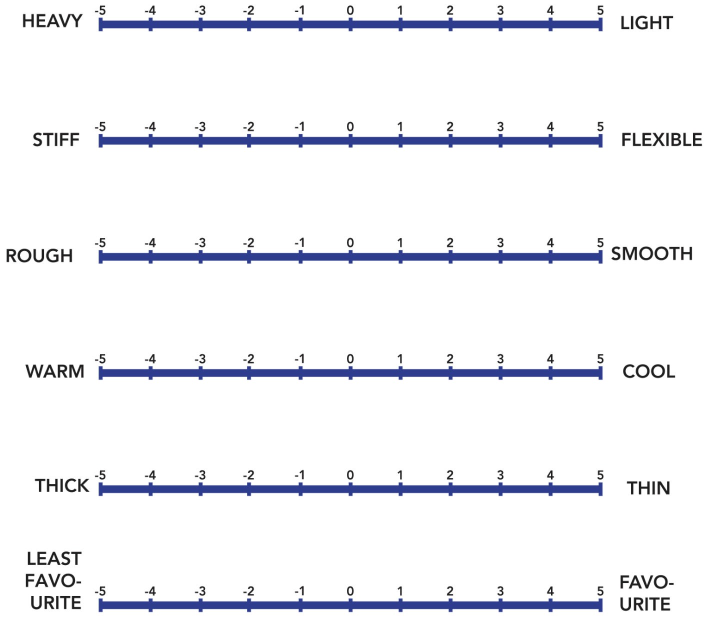

Figure 4 Bipolar scales used in both workshops.

Next, the *Define* stage used the bipolar scales shown in Figure 4, inspired by previous studies and standards (Atkinson et al. 2016; ASTM Standard D123-83a; Behery, 2005) for textile assessment. The Individual workshop assessment scale was designed on six A3 sheets and utilised large numbered stickers to rate each material, unlike plotting small dot stickers which are difficult to adjust or permanent pen marks (Figure 5a). This concept was developed further for the Group workshop, where the scales were presented digitally, on a Miro board (Figure 5b). Participants dragged digital material dots onto the scales to facilitate ease of group consensus.

Figure 5 a. Individual (paper-based) assessment, b.Group (digital) assessment.

3.4 Ideation process

In the third stage, *Develop*, participants developed ideas through reflecting and ideating on the previous assessment activity. The Individual workshop's brainstorming portion questioned how AI collaborations enhance material assessments, and the results were presented previously (Ma et al., 2023). The Group workshop had participants filling out a digital *Idea Napkin* on Miro boards, shown in Figure 6, to have each group reflect on physical assessment as a group, identify limitations, and come up with solutions highlighting the benefit of their ideas.

Figure 6 Digital Idea Napkin.

The final stage of the workshop, *Deliver*, concluded with participants sharing a brief summary of their concepts. The Group workshop participants were able to consolidate their ideas into an elevator pitch which they presented to the room.

4. Results

4.1 Material assessment data

The quantitative assessment data was analysed in two ways. First, what is the difference of the material assessment results between individuals and groups? Second, we attempted to understand the designers' perspectives through ordering the six properties in levels of subjectivity.

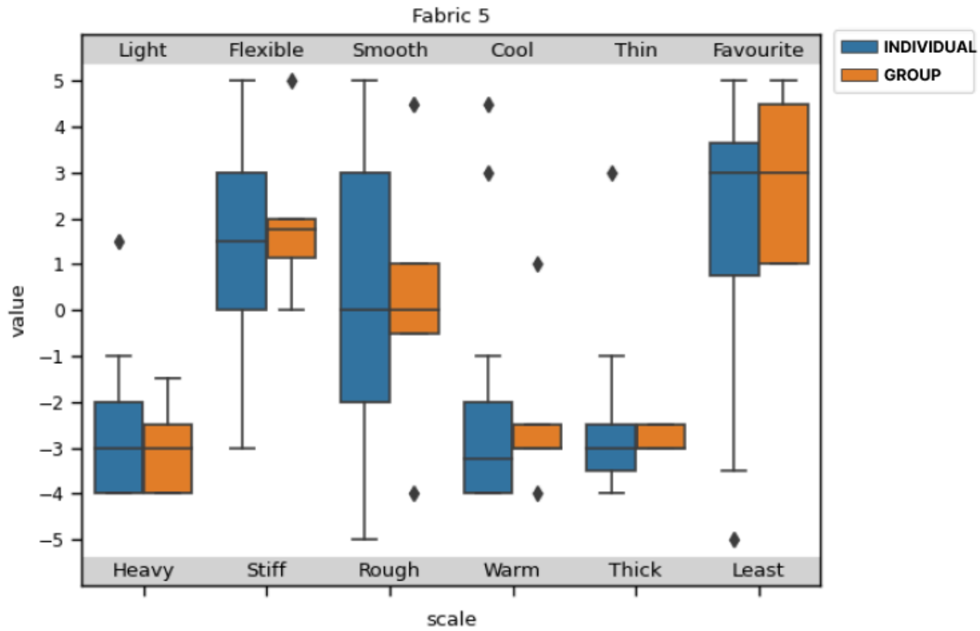

Figure 7 Boxplots for Fabric 5 comparing Individual (blue) and Group (orange) material assessments.

Figure 7 shows an example boxplot of the material assessment data (vertical axis) for a single fabric, comparing the six bipolar scales (horizontal axis). Visually, the median values for both workshops are close, but not for every fabric (see Figure 15 for all fabrics).

We compared the correlation between the Individual and Group workshops for each of the bipolar scales, with Spearman's rank correlation of the participants' median values for each fabric (Table 3). Except for *Least-Favourite*, the scale's median values correlated between Individual and Groups workshops ($r > 0.8$, where a r-value of 1 is identical correlation) with statistical significance ($p < 0.01$). *Thick-Thin*, *Heavy-Light* and *Rough-Smooth* showed high correlation ($r > 0.9$), which indicates Individual and Group workshops can both provide convincing assessment data representing a group decision for the same material.

Table 3 Spearman's rank Individual and Group of the fabric scales (in order of correlation)

Scale	Correlation r
Thick-Thin	0.997**
Heavy-Light	0.997**
Rough-Smooth	0.920**
Stiff-Flexible	0.890**
Warm-Cool	0.829**
Least-Favourite	0.676*

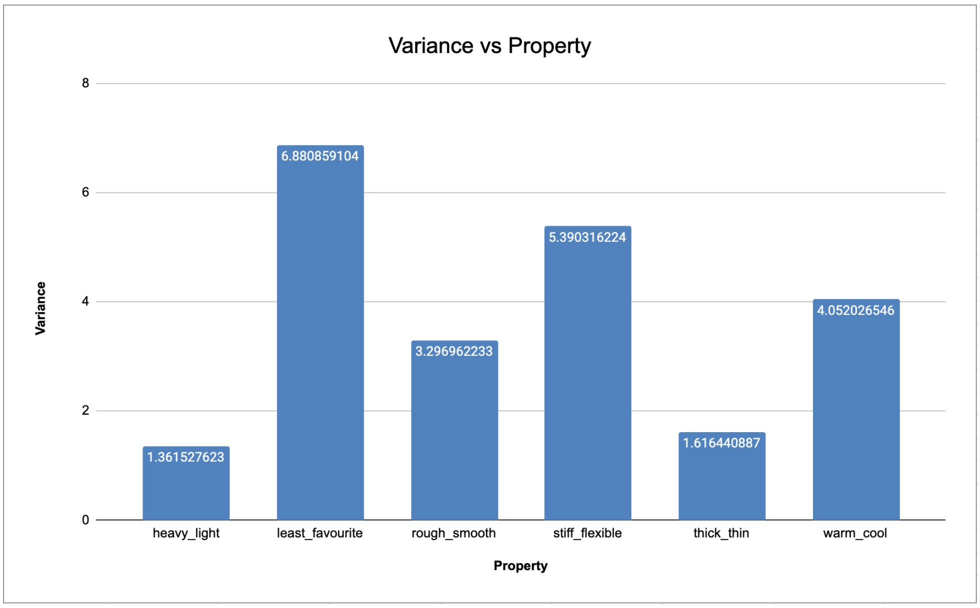

Figure 8 Average variances of properties' ratings from two workshops.

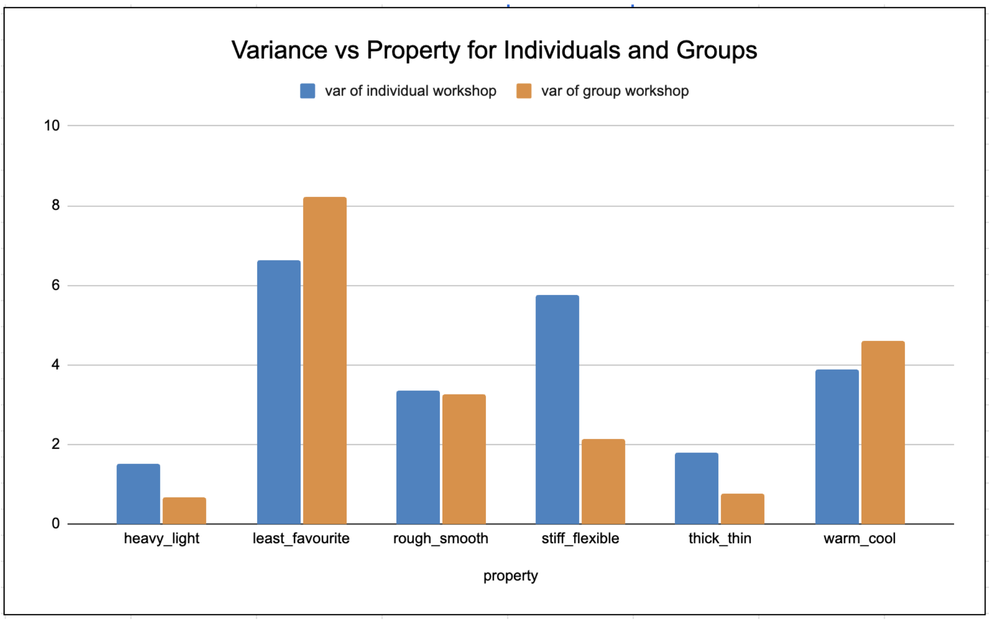

Figure 9 Average variances of properties' ratings from Individual vs Group workshops.

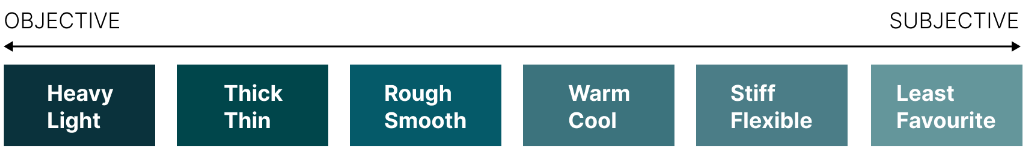

Figure 10 Material properties' subjective order.

We calculated the variance of each subjective property, shown in Figure 8 (combined averages of both workshops) and in Figure 9 (separated by each workshop). The overall property variance of Individual and Groups workshops are 3.82 and 3.28 respectively (out of the 11 point bipolar scale), possibly due to Group workshops having smaller sample sizes. *Heavy-Light* has the lowest variance (1.36), which means a large number of users view this property in a same/standard perspective, being more objective. Whereas *Least-Most Favourite* has the largest (6.88) and is arguably more subjective. Figure 10 shows the properties' variance-subjectivity rankings with a similar ordering to the correlations in Table 3.

4.2 Ideation data

With the ideation data from the Group workshop, we looked for ideas on how to improve the process of textile hand assessment. The 5 groups' digital sticky notes (Figure 11) were classified into the following categories: *Reflections* about this workshop process and the assessment method, *Limitations* of the points listed in the reflection, *Solutions* targeting those limits, and *Benefits* of the proposed solutions.

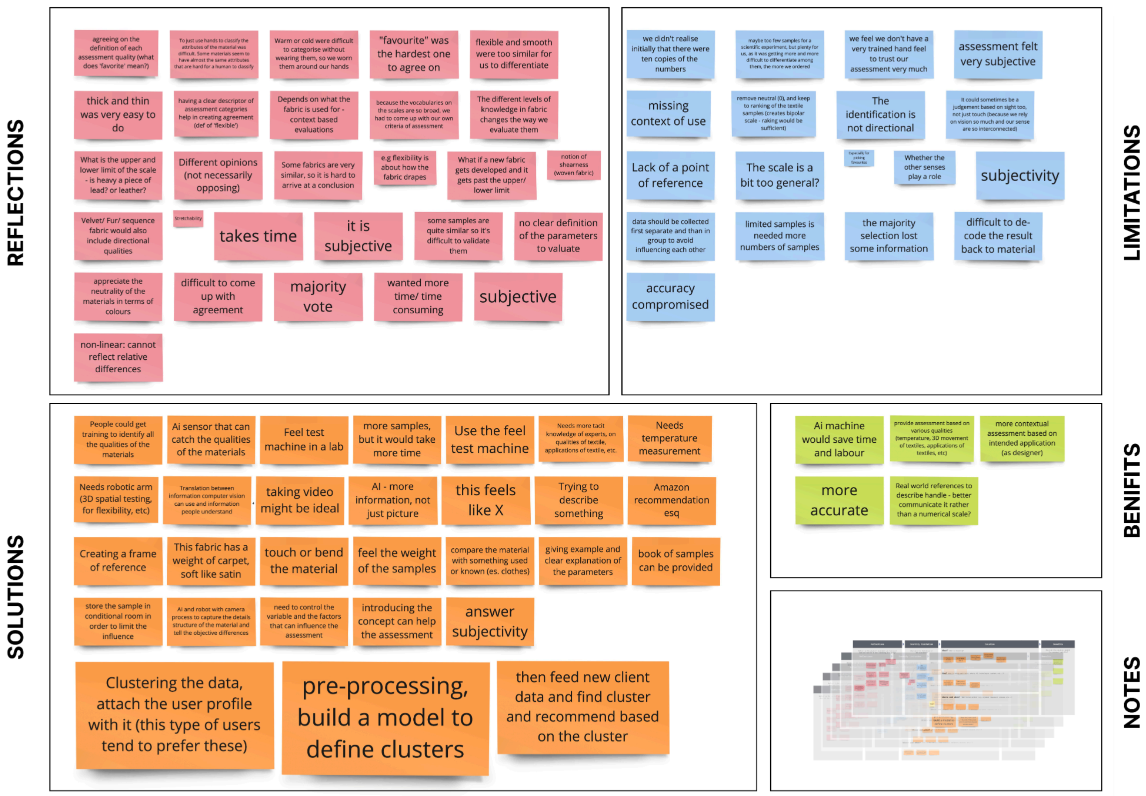

Figure 11 Participants' Idea Natkin sticky notes.

Reflections. Responding to the prompt: *"How did you value the physical assessment you have just done and how did it work assessing as a group?"*

> “The "favourite" was the hardest one to agree on, “flexible” and “smooth” were too similar for us to differentiate, and "thick" and "thin" were very easy to do.” (Group 2)

> “The different levels of knowledge in fabric changes the way we evaluate them.” (Group 3)

> “Because the vocabularies on the assessment are either broad or lack-of-definition, we had to come up with our own criteria of assessment.” (Group 3)

Limitations. Several limitations noted was that translating the ratings onto Miro board was inconvenient, and the time to get agreement in group. In particular, they mention limitations of the scales: lack of consensus on the definition of the bipolar properties, limited samples, and subjective differences of the properties.

> “First of all, the category and its scale lacks a clear definition on texts for participants to understand the criteria.” (Group 2)

> “Secondly, there is a gap between a physical assessment and a digital co-design platform (like Miro). It’s time consuming to decode the assessment result, especially in a group.” (Group 5)

> “Last but not least, participants cannot figure out the baseline of those materials with a limited sample.” (Group 4)

Solutions. The groups generated solutions on how this subjective assessment can be improved and used in an industry scenario. For the assessment structure and materials, one group recommended inclusion of textiles from our daily used clothes, and also provide physical reference (material samples) and digital reference (ie. Images, link in Amazon) for each bipolar property as a clarifying explanation. For the future development of the material subjective assessment, several groups suggested adopting AI tools to “learn” from subjective assessment results.

Benefits. The groups proposed clarifying the assessment scales would benefit data accuracy. And the benefits of AI-enabled subjective assessment platforms on labour-saving and time-saving, are also highlighted by groups.

All five groups gave an elevator pitch of an innovative idea on how this workshop might be improved and the unique usage of the assessment data. Based on the pitch session, 5 main topics (Figure 12) are highlighted: Assessment Process, Subjectivity, Challenges in Group Evaluation, Time Constraints of Group Workshop, and Assessment Vocabulary.

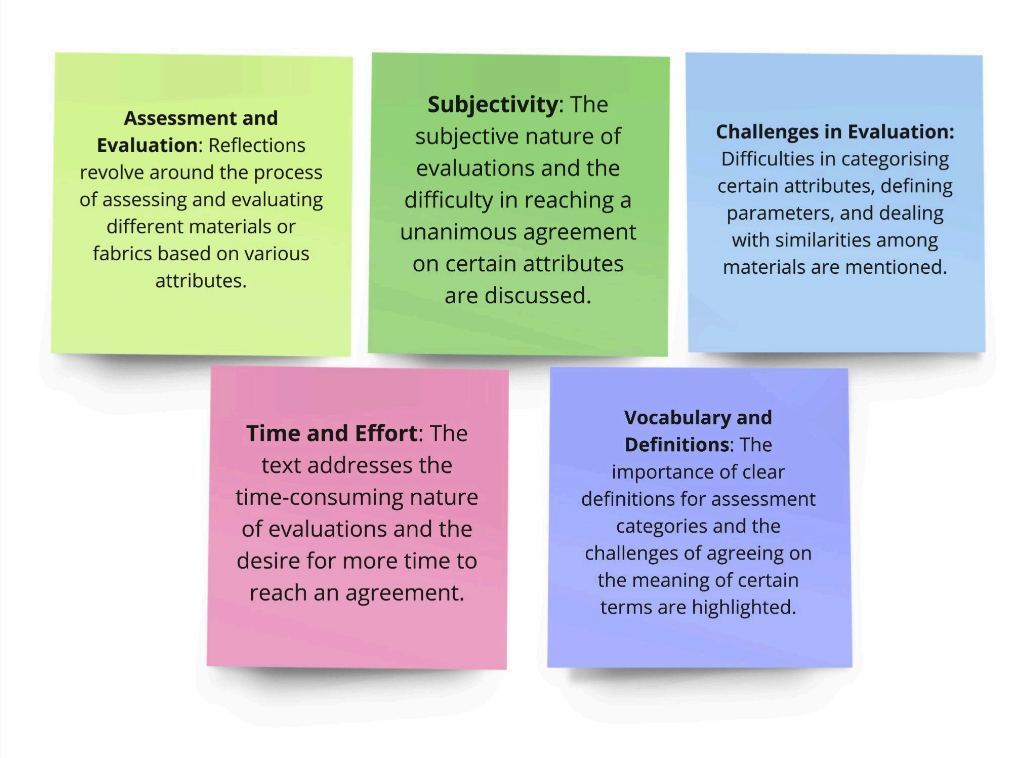

Figure 12 Conclusion of the Theme.

5. Discussion

In this section, we discuss differences between the workshops, present several ways to improve the workshop experience and identify limitations from this study.

5.1 Differences between Individual and Group workshops

Individual and Group workshops produce similar subjective data. Each material was rated similarly by participants assessing individually and within groups. We found high correlation ($r > 0.9$), based on Spearman's ranking, between the scales with lower variance within each workshop – *Thick-Thin*, *Heavy-Light* and *Rough-Smooth*, and correlation ($r > 0.8$) with *Stiff-Flexible* and *Warm-Cool*, <u>meaning both workshops could represent subjective data for these scales</u>. This corresponds with the findings of Atkinson et al. (2016) between non-expert groups of 2-3 and individual experts, of high correlation ($r > 0.9$) for *Flexible-Stiff*, *Thick-Thin*, *Warm-Cool*, *Rough-Smooth*. *Least-Favourite* has the most variance and least correlation, which makes sense as it is the most subjective of the scales as fabric preference.

The observation on how groups came up with a final decision provides insight on these similarities. Group 2 reported: "We vote for the one we agree on, taken out of the poll, and then selected the second best matching criteria". Most groups first assessed individually, and then came up with final decisions with a group vote, while Group 5 averaged individual assessment properties.

Adequate data collection in the Individual workshop. The Individual workshop produced a larger data set (n=25) compared to the Group workshop (n=5), which improves the confidence in the quantitative analysis and reduces statistical error comparing subjective properties with previous studies (Adkinson et al. 2016). Additionally, the assessment section of the Individual workshop takes less time compared with the Group workshop, which will be more appropriate for a crowdsourcing approach for collecting as much data and as less time consuming, ie. in a street survey or online survey.

Thoughtful discussion in Group workshop. Observing the assessment (*Define*) stage of both workshops, the Group workshop provided users a better opportunity to both reflect and ideate, where the Individual workshop had participants working in quiet exam-like solitude. While both workshops' participants gained a working understanding of the subjective assessment process based on our introduction, the Group workshop participants conducted in-depth discussion of the textile comparison process. For example, conversations were often about "definitions of vocabulary of certain properties" and solutions to disagreements about ratings, usually involving a new material to compare and then voting or averaging them out. **The Group workshop enabled the researcher to observe users' subjective evaluation process, as opposed to the subjective evaluation in the Individual workshop being more internal and less obvious.** This is similar to what Bang and Nissen (2009) found with their RP group textiles, where they were conducted over a week-long course and were less structured as the Group workshop. In addition, the ideation stage between group members provided a speak-loud space to review the assessment structure and tools due to previous disagreements during the assessment stage. For example, the ambiguity of vocabulary in the assessment was raised, and in response to this issue, using sub-description and pictures or physical materials to describe the two ends of the scale were proposed.

5.2 Improving participant's experience of the workshop

Providing comprehensive introduction on context. Different backgrounds influenced the workshop ideation, so providing a comprehensive introduction and a clear objective before the workshop is essential. In the Individual workshop, most participants had STEM-related backgrounds, which led to technology-focused discussions (e.g. using robots to evaluate textile hand), while the Group workshop participants had varying design backgrounds, and they ideated on how such subjective tests could help the design process.

Combining digital and physical toolkits. In both workshops, users were excited to touch the physical materials. Physical assessment tools helped users focus on the material samples, whereas digital assessment tools forced users to concentrate on screens. Despite the Group workshop participants being provided digital scales, many also chose to start assessing physically with paper and pen or ordering materials on tables before scoring on the digital board. The use of tangible toolkits allowed for a more immersive and natural interaction with the workshop users, whereas the digital tools added an extra stage for the Group participants. However, physical assessments are harder to adjust for users, and are also harder to decode results for the researchers. Physical tools will elevate the difficulty of data collection, especially with a large number of participants.

5.3 Limitations

Limited participants. Workshops conducted in a group format may result in smaller sample sizes compared to participating in independent workshops. Statistical significance is harder to tell because of the limited data. We lacked sufficient users to conduct the workshops.

Measuring two separate variables. Our two workshops had two separate structural variables that discerned them: individual/group participants and physical/digital assessment tools. They were not designed to be exclusively comparative experiments between individuals and groups, which would have caused problems when conducting rigorous quantitative comparisons between individuals and groups.

Limited time. Time constraints also affected the effectiveness of the workshop at each session, making it difficult to compress a large amount of subjective testing and discussion of material into a single afternoon.

6. Insights

In the two workshops on subjective assessment of materials, we discovered two insights to contribute towards possible future work on workshop methods with digital toolkits and the future application to scale up the assessment to a digital product.

6.1 Future subjective assessment workshops with digital toolkits

A tool that facilitates comparisons. Similar to previous studies (Bang and Nissen, 2009), workshop participants use comparisons to measure materials. In the subjective evaluation of materials, 3 materials with little differences were singled out for comparison, and sometimes 3 materials with large differences were also singled out to help users re-verify their ratings. So, when we move the “textile hand” to a digital platform, the comparison feature can be helpful to users to locate their ideal material, enhancing the user experience.

A common example is the multi-product comparison tool on an electronics sales platform, as shown in Figure 13a, which can improve efficiency when making complex measurements from multiple perspectives. Therefore, future workshops might use three parallel material checkboxes (Figure 13a), or a tangible frame that can fix three or more material samples together to evaluate the efficiency and engagement as a design toolkit.

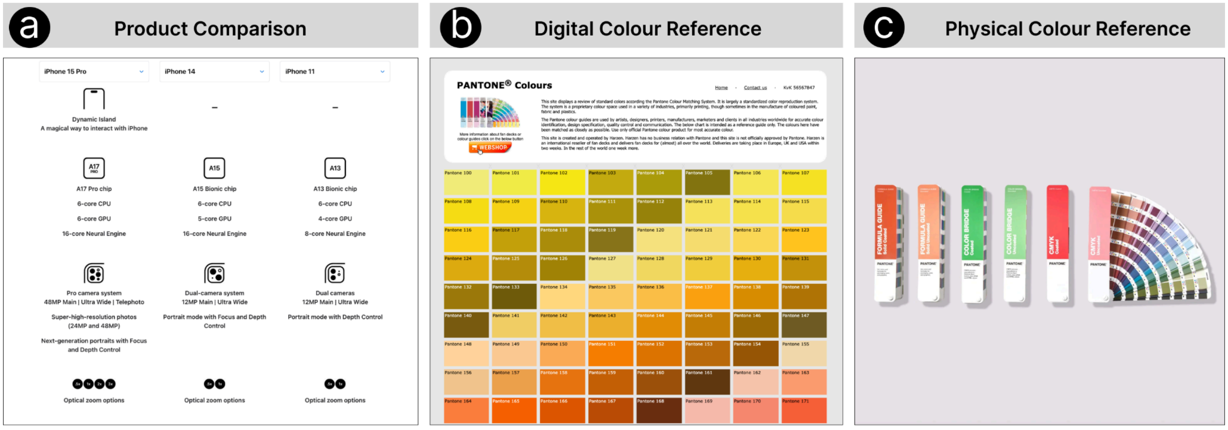

Figure 13 Toolkits for comparison and reference in the digital era. a) Apple's webpage[1] has a product comparison feature that helps users to choose the one that meets their requirements among many iphones. b) Pantone's online colour tool [2]with its colour code helps users to see the colour that the code stands for c) Pantone's physical colour card [3]makes it easy for designers to compare the colours physically.

An easy-to-access reference. Lack of understanding of what the scale parameters represent made it difficult for users to read the scale or plot their assessments. Future work will focus on the references to describe the scale in more detail. As shown in Figure 13b, for example, the index Pantone colour gives the designer an intuitive sense of the tone represented by the numbers when selecting colours. Despite decoding subjective values for specific materials not being a main focus of the workshop, it is, however, useful to provide users with a reference for understanding property measurements. Future work will involve building index libraries of everyday materials to make the scales more meaningful, such as cashmere scarf or a leather belt, as their sensory data is widely known and understood.

6.2 Digital platform for materials subjective data

The context of this study of the workshops is to understand the effort to use subjective evaluation and the digitisation of its collection and presentation. This provides a reference for future scenarios that capture users' subjective evaluations through purely digital means and help designers use this data, such as an app or online webpage. As shown in the process demonstrated in Figure 14, users can complete subjective evaluations of materials online by sliders, and at the same time they can see the statistical results of the evaluations in a database. Designers can use the users' subjective evaluation scale, such as in Figure 14c, to understand the characteristics of the material in the users' mind, and to understand the characteristics such as their favourite or the feeling of warmth, so that the material selection process can have more dimensions of reference.

[1] https://www.apple.com/iphone/compare/
[2] https://www.pantone.com/graphics
[3] https://www.pantone.com/products/graphics/formula-guide-coated-uncoated

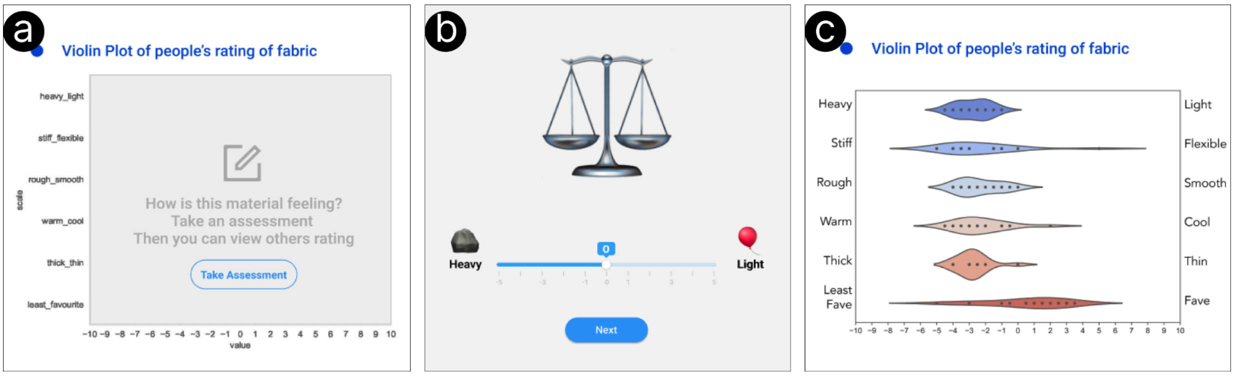

Figure 14. Designing a platform for collecting and presenting subjective data . a) Guiding users to participate in subjective evaluations. b) Demo assessment of material weights c) Violin plot to display all subjective data in the database to help designers or users to get a subjective experience of the material remotely.

7. Conclusion

This paper has looked at two subjective assessment workshops of 10 textile materials, discussing the format and tools of workshops, and the suggested improvements of the "textile hand" process and its application in the digital era.

The Textile Assessment workshop formats show that the Individual workshop has advantages in assessment efficiency to produce a sufficient amount of data, whereas the Group workshop provides more opportunities in thoughtful brainstorming and ideation through discussion. The data also shows that the bipolar textile assessment scales vary in subjectivity, in the following objective to subjective order: *Heavy-Light, Thick-Thin, Rough-Smooth, Warm-Cool, Stiff-Flexible* and *Least-Most Favourite*. Through the ideation stage to improve the assessment, participants suggested that defined parameters would make the scales more objective. In conclusion, displaying index materials on these scales would offer participants collective reference points and rate new materials with these in mind.

Comparing the physical tools to the digital tools, the assessment process was richer and more collaborative in the digital version. Through the ideation stage, it was suggested that the use of digital technologies in textile assessment allow for more accurate and valuable ratings, such as the digital material dots plotted on the scale on the Miro board, overlaying index materials on the scales, and offering a comparison interface. The outcomes of the ideation stage give strong suggestions to improving the process of sourcing and selecting materials online and using digital tools to design with. Overlaying generic materials data provides parameters, and clustering materials data collectively allows the user to compare and refer to, simulating the physical sourcing experience. As future work, the insights from Section 6 suggest user interfaces to transfer this subjective assessment of materials into a digital approach.

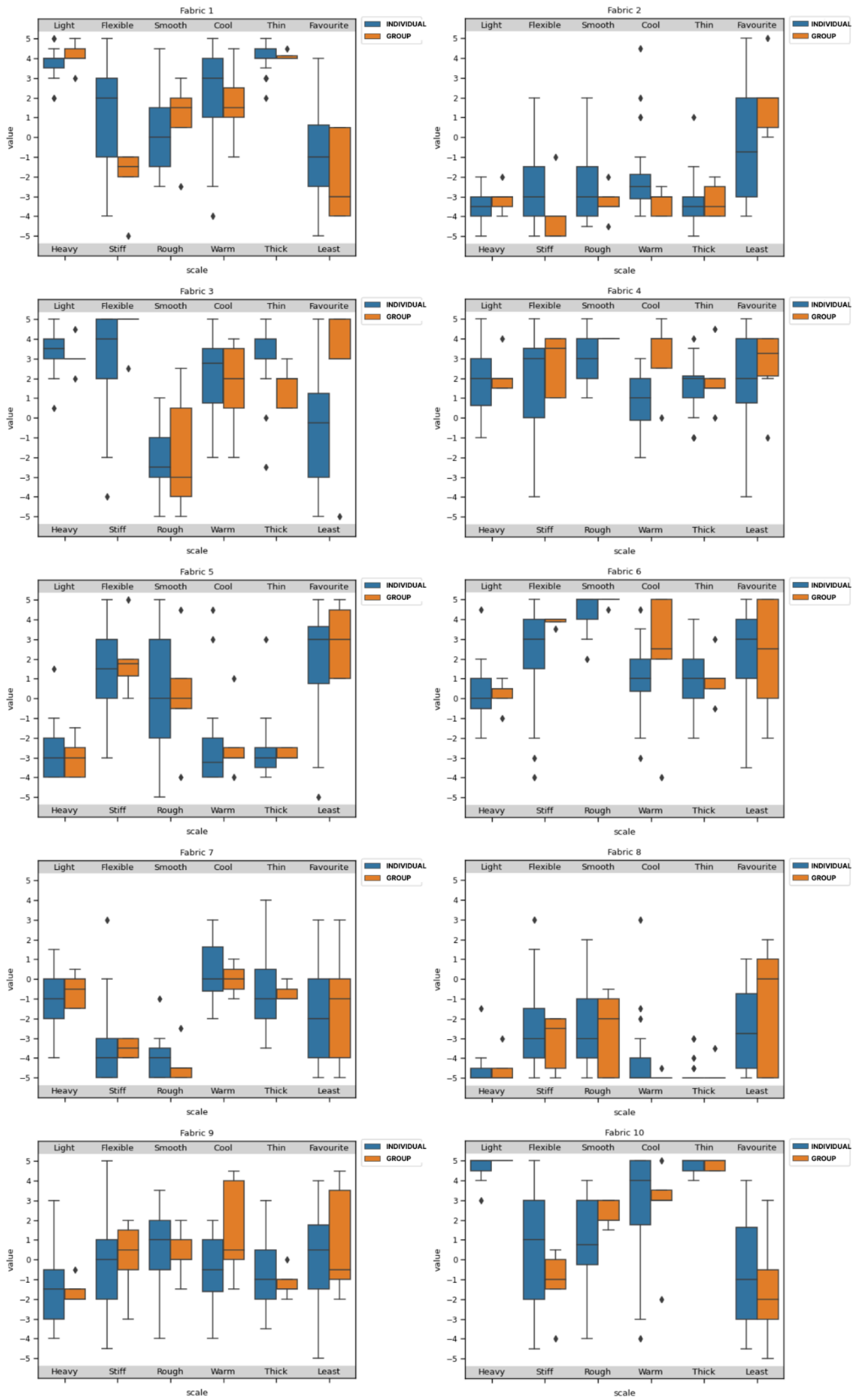

Figure 15. Material assessments for all fabrics, results from Individual assessment and Group assessment are demonstrated in blue and orange separately.

Acknowledgements: This research is funded by the Laboratory for Artificial Intelligence in Design under the InnoHK Research Clusters, Hong Kong Special Administrative Region Government and led by a collaboration between two research projects – Human-centred AI Design (RP2-4) at Hong Kong Polytechnic and Intelligent Design Systems for Innovation (RP2-5) at the Royal College of Art.

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