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Perception of naturalness in textiles

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ABSTRACT

In many daily contexts, we prefer natural 'materials' over un-natural ones. Textiles embodied in garments that are worn on the body all day, or in bed sheets slept under every night touch us literally, on a daily basis. Hence among all other materials, 'naturalness perception' has a strong impact on the preference for textile products. Nevertheless, a stark gap can be found in literature articulating when people appraise textiles as natural. Grounding on previously conducted studies on textile perception, we present an empirical study in which we determined three main aspects which might influence the perception of naturalness in textiles: (1) fiber origin, what it is actually made of (natural vs. artificial, or mixed), (2) yarn type (fine vs. thick yarn), (3) exploration mode, i.e. how people interact with textiles (e.g. touch only, vision only, both). The results show that pure wool and pure cotton textiles are perceived most natural. While mixing wool and cotton with polypropylene destroys the perception of naturalness, mixing in acrylic does not. Moreover, a thick yarn is perceived as most natural. No differences were found for exploration modality. We discuss our results in the light of design in textiles.

1. Introduction

In many daily contexts, natural materials have the potential to be preferred over un-natural ones (e.g., [22,27]). The preference for natural has been shown for food and medicines [28,27], for landscapes [25], also in cross-cultural studies [15]. These studies showed that people often believe that natural things are healthier, more appealing to the senses, or more environmentally friendly. As a result, perception of 'naturalness' might strongly influence people's decisions made in many everyday contexts, such as when choosing what to eat or selecting what objects to use or which clothes to wear.

In product design, even though it highly depends on the context in which a material is embodied in a product and appraised by people [17], the fact that 'it is' or 'it feels' natural often plays an important role on the commercial success of a material [18]. Over the past decade, expressing 'naturalness' through material qualities has also gained momentum within the design for sustainability discourse [26,19,29,14,11,22,13,18]. To assure easy acceptance and consumption of sustainable products by a vast amount of the population, the materials of such products – how they please one's senses, and what kind of meanings they evoke [17] – are crucial in design with eco-sensitive materials [19]. These experiential qualities largely affect (either positively or negatively) consumption of sustainable products in societies [21,23,36,41,37,18].

For one particular material family, experience of 'naturalness' plays a crucial role: textiles. Textiles in garments that are worn on the body all day, or in bed sheets that are slept under every night touch us literally, on a daily basis. Thus, textiles that look and feel natural and also feel comfortable to touch are suggested to bring positive experiences to their users in many contexts. There are a number of factors proved to be influential in the textile sensorial comfort [20]: fiber type (e.g. natural, artificial, etc.), yarn type, production method, method and type of dyeing and finishing processes (heat treatment, brushing, coloring, softening, etc.), exploration mode (i.e. touch vs. vision; [2,38]. However, it is remarkable that there has not been any thorough study into the perception of the feel and look of naturalness in textiles.

In earlier studies, we have investigated when other materials are perceived 'natural' [18,22,19]. In two sequential studies [18,19], Karana et al. explored when people think that a material expresses 'naturalness'. A group of people were approached to participate in a study where they were given the following three tasks: (1) select a material that you think expresses 'naturalness', (2) provide a picture of the material you selected, and (3) explain your choice and evaluate the material on the given sensorial scales

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(see [18]). Analyzing the results, we could find three significant properties playing an important role in the attribution of naturalness meaning to materials: fiberness (materials with visible fibers are perceived more natural), glossiness (glossy materials are perceived less natural), and roughness (rough materials are perceived more natural). There were only few textiles selected by participants as examples of materials, which expressed naturalness. Those textiles were made of 'animal skin' (e.g. leather, fur, etc.). In a follow up study, we could substantiate these findings with empirical research by delving into our understanding of the effects of these previously detected properties and their inter-relationships on the attribution of 'natural' meanings to materials, by creating varieties of these material properties embodied in two different products: a tray and an I-Phone case (see [19] for details). These two studies gave us a very rough idea on the possible attributes that might affect the perception of naturalness in textiles. Roughness is one of these attributes, which we will explore in the current study by varying the yarn type (fine vs. thick yarn). Accordingly, we expect to find that textiles made of tick yarns will be perceived more natural, as they are rougher compared to fine yarns. Another attribute is the fiber type (i.e. whether it is inherently natural or artificial, or mix), which will be explored in this study.

In the Overvliet and Soto-Faraco [22] study, we investigated how sensory input (vision and touch) contributes to the perception of naturalness in a number of natural and artificial wood samples, such as vinyl and veneers. In three separate experiments, Overvliet and Soto-Faraco investigated the contribution of vision and touch by asking participants to rate individual samples on a scale of naturalness after having explored a sample in one of three possible exploration modalities (vision only, touch only, and visuo-tactile). The results showed a high degree of consistency across sensory modalities. Moreover, we showed that participants were actually quite accurate in classifying purely natural and artificial samples, especially in the context of similar materials, e.g. real oak and imitations thereof vs. real oak and imitation pine. A question that still remains is how natural one perceives mixtures of artificial and natural materials, a situation often encountered in textiles.

In this paper we will investigate the perception of naturalness in pure (as natural or artificial) and mixed textiles. It has been shown that some artificial textiles last much longer than natural ones and will have a smaller environmental footprint and are thus more sustainable [34], yet their aesthetic features (i.e. how they look, touch and feel) are usually not comparable to the natural ones. We suggest that an alternative may be to create mixtures of natural and artificial materials that look and feel like natural materials, but are as durable as artificial textiles. For example, research has shown that 50/50 cotton–polyester mixes are likely to last twice as long as 100% cotton sheets so may have a significant reduction in environmental impacts [16], and may have comparable aesthetic features. Moreover, these 50/50 sheets require much less industrial drying time as compared to 100% cotton sheets, which is a large gain over the complete lifecycle in terms of environmental impact [34].

A large body of literature has already focused on textiles, and one of the common ways to describe the feel/touch of textiles is the term "hand" or "handle", which is influenced by many factors, both physical and sensorial (such as softness, stiffness, or roughness) as well as the end use of a specific material [1,5,24]. Physical parameters like softness or stiffness are relatively easy to measure, which also holds for their human sensorial counterparts (e.g. [3]). However, if we want to measure how natural a textile is perceived, we cannot measure this objectively: the relevant physical properties are in principle unknown, so it would not be possible to describe the relationship between those physical properties and their subjective counterpart (perceived naturalness) as it would traditionally be done in a psychophysical study [9]. In our earlier study [22] we circumvented this problem by using and comparing multiple scaling methods: binary decision, free modulus magnitude estimation, labeled scaling and ranked ordering. We will use the same method in the current study (see Section 2).

In order to investigate the underlying mechanisms of naturalness perception in textiles we systematically manipulated three factors. First of all, we varied *exploration mode*, by asking participants to explore by vision only, touch only, or a combination of both modalities. Note that the some perceptual characteristics can be estimated by vision only (e.g. color), others by touch only (e.g. thermal conductance) and others can be experienced by a combination of both sensory modalities (e.g. texture). However, we cannot predict which material characteristics will lead to perception of naturalness, and therefore we do not know whether visual or tactile sensory estimates are more important. Moreover, the results of several studies investigating cross- modal and multisensory perception suggest that these modalities perceive textures in qualitatively different ways (see for an overview: [38]). Along these lines, despite to previous findings in the perception of naturalness in the particular case of wood [22], one might still expect possible differences between modalities in the perception of naturalness in other cases, such as textiles.

Secondly, we varied the *type of yarns* that has been used (thick vs. fine yarns). We reasoned that rougher materials are perceived as more natural [18], as Rozin [27] suggested that the more a material is processed the heavier its naturalness is destroyed. Moreover, from a sustainability viewpoint, a thicker yarn requires less energy consumption for weaving [34]. Thirdly, and most importantly, in order to explore our main assumption that mixtures of natural and artificial textiles may be perceived as natural as 100% natural textiles, we varied *the origin material* that comprised the textile samples; we used 4 types of materials, two of them were natural (cotton and wool) and the other two artificial, or synthetic, (acrylic and polypropylene). Some samples were made of one of these four materials, while others were the mixtures of two of these materials with different percentages. We hypothesize that (1) pure natural textiles are perceived most natural, and that mixing materials will partly destroy naturalness (c.f. [27]), (2) this might be significantly affected by the specific type of the material (i.e. combination of 'cotton and acrylic' and 'cotton and polypropylene' – in exactly similar amounts – will generate different results), (3) and the type of yarn, so rougher samples, will be perceived more natural regardless of the material combination.

2. Method

2.1. Participants

Thirty-two participants (20 female, 12 male; 30 right-handed, 2 left-handed; mean age 23.2, range 17–33) took part in this study. Sixteen of them participated in both labeled scaling and the binary decision task, and the other 16 participated in magnitude estimation and the ranked ordering task. All participants had normal or corrected to normal vision, normal touch, and had no expertise concerning textiles.

2.2. Stimuli

Forty-four different pieces of textiles, made of wool, cotton, acrylic and polypropylene, were customly weaved to be used as stimuli in this study. They were either weaved using just one of the materials, or in a mixed form of 2 of the materials (all 6 possible combinations): 25%/75%, 50%/50% and 75%/25%. In the 50%/50%

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mixture both the warp and the weft consisted of threads of a single materials, in the 25%/75% and 75%/25% mixtures the warp consisted of alternating threads of the two materials and the weft consisted of threads of a single material. For each mixture we used both a fine and a thick yarn. In total 44 samples were weaved, by using a balanced plain weave, a description and pictures of the samples can be found in Fig. 1.

The textile samples were wrapped around a $8 \times 8 \times 0.5$ cm piece of multiplex and were mounted in $12 \times 12 \times 5.5$ cm gray plastic boxes, so that only the top surface of the samples could be explored through a window of 8×8 cm. When presented to the participants, the samples were all shown with the warp aligned with viewing direction (see inset of Fig. 2).

2.3. Procedure

The participants sat behind a table in front of a $80 \times 80 \times 80$ cm photographic daylight tent, which was illuminated by six 50 W white daylight 5000 K light bulbs. In this way the samples were illuminated under constant lighting conditions with scattered light. In the tactile exploration the front of the light tent was covered with a white cloth to prevent the participants from seeing the sample. The temperature in the experimental room was kept at about 20 °C. To exclude the possible influence of acoustic cues while exploring the samples, the participants were wearing headphones, which played white noise at a sound pressure level sufficient to mask the sounds produced by the tactile exploration of the samples. The participants washed their hands with glycerin soap and dried it with paper towels before the task, and whenever they needed during the experiment. A photograph of the setup is shown in Fig. 1.

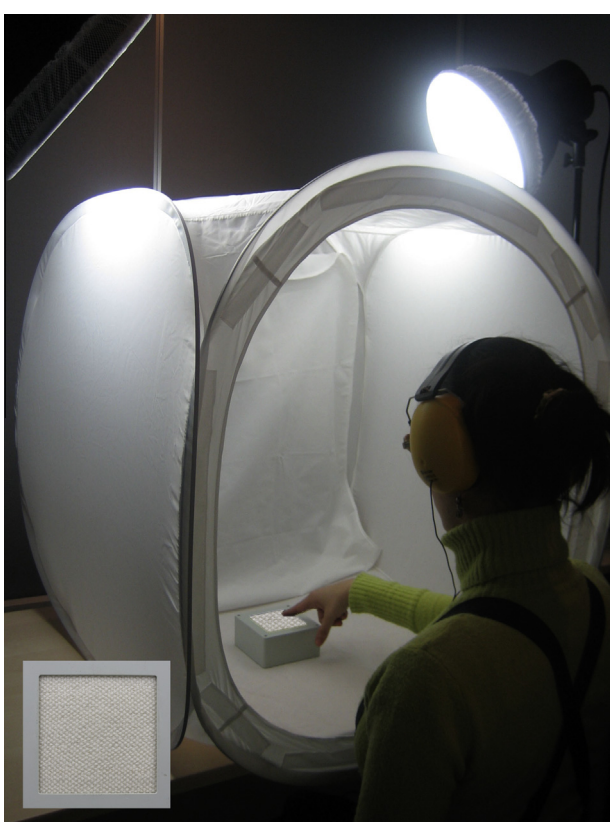

Fig. 1. A participant exploring a stimulus in the visuotactile condition. The inset shows one of the stimuli.

Each trial started by the researcher placing a sample in the middle of the bottom of the daylight tent, from an opening at the back. If visual input was allowed, the participant viewed the sample at a distance of approximately 50 cm, at an angle of about 45° (participants were asked to maintain head posture stable, but their heads were not restrained). The participant had then to explore the sample, either visually, tactually or visuo-tactually for 3 s. In the visual exploration condition, participants could see but not touch the sample, and could freely explore it. In the tactile exploration condition they were asked to make circular movements with the finger pad of the index finger of their dominant hand, so that the participants would actively touch the samples in all possible directions. Finally, in the visuo-tactile condition participants used both exploration modalities. After the 3 s exploration phase the experimenter removed the sample and the participant had to rate its naturalness according to one of three measurement methods: labeled scaling, binary decision, free-modulus magnitude estimation and ranked ordering, which will be described in the following section.

2.4. Measurement methods and analysis

Since the physical properties that are relevant to naturalness are in principle unknown, it is not possible to describe the relationship between physical parameters of the stimuli and their subjective correlate, perceived naturalness, as it would be done in the classical psychophysical approach [9]. However, the attempt to use psychophysical methods to address ill-defined psychological constructs, such as the aesthetics of abstract forms [8] or the seriousness of a criminal offence [33] is almost as old as modern psychophysics itself. In order to measure this type of properties, one must agree on the type of psychological scale emerging from the data, and it is generally accepted that a powerful type of validation is to show consistency of the measured property across different measurement methods (see for more details: [4]). In the present study, we evaluated the measurability of naturalness therefore by using four different methods: labeled scaling, binary decision, free-modulus magnitude estimation and ranked ordering.

2.4.1. Labeled category scaling (LS)

The participant was asked to label each stimulus according to a 7-point scale with labeled categories. Using a labeled (instead of a numerical) scale makes it less likely that participants adopt a strategy that equalizes response frequency for each category [9]. We translated Rozin [27] scale for the perception of naturalness (of foods) to Spanish. The original (English) version is as follows: 0 = not natural at all; 1 = very slightly natural; 2 = slightly natural; 3 = moderately natural; 4 = very natural; 5 = extremely natural; 6 = completely natural. We rescaled the results to a 0–1 scale to make them readily comparable to the other measurement methods.

2.4.2. Free modulus magnitude estimation (ME)

This method is based on the magnitude estimation method as described by Stevens [32]. Participants were asked to assign an arbitrary numerical value to the first stimulus, and then assign numbers to the following stimuli accordingly, trying to capture the ordering and subjective distance between stimuli for the judged property (naturalness, in this case). They were allowed to use any number they liked. Unlike in the labeled category scaling, we explicitly asked the participant to compare the different stimuli to each other. The numerical scores the participants had given were averaged by computing the geometric mean ([9], Chapter 11), and then re-scaled linearly (between 0 and 1) in order to make this measurement readily comparable to the other methods. Despite inter-individual differences in the estimations, the results obtained with free modulus magnitude estimation often appear

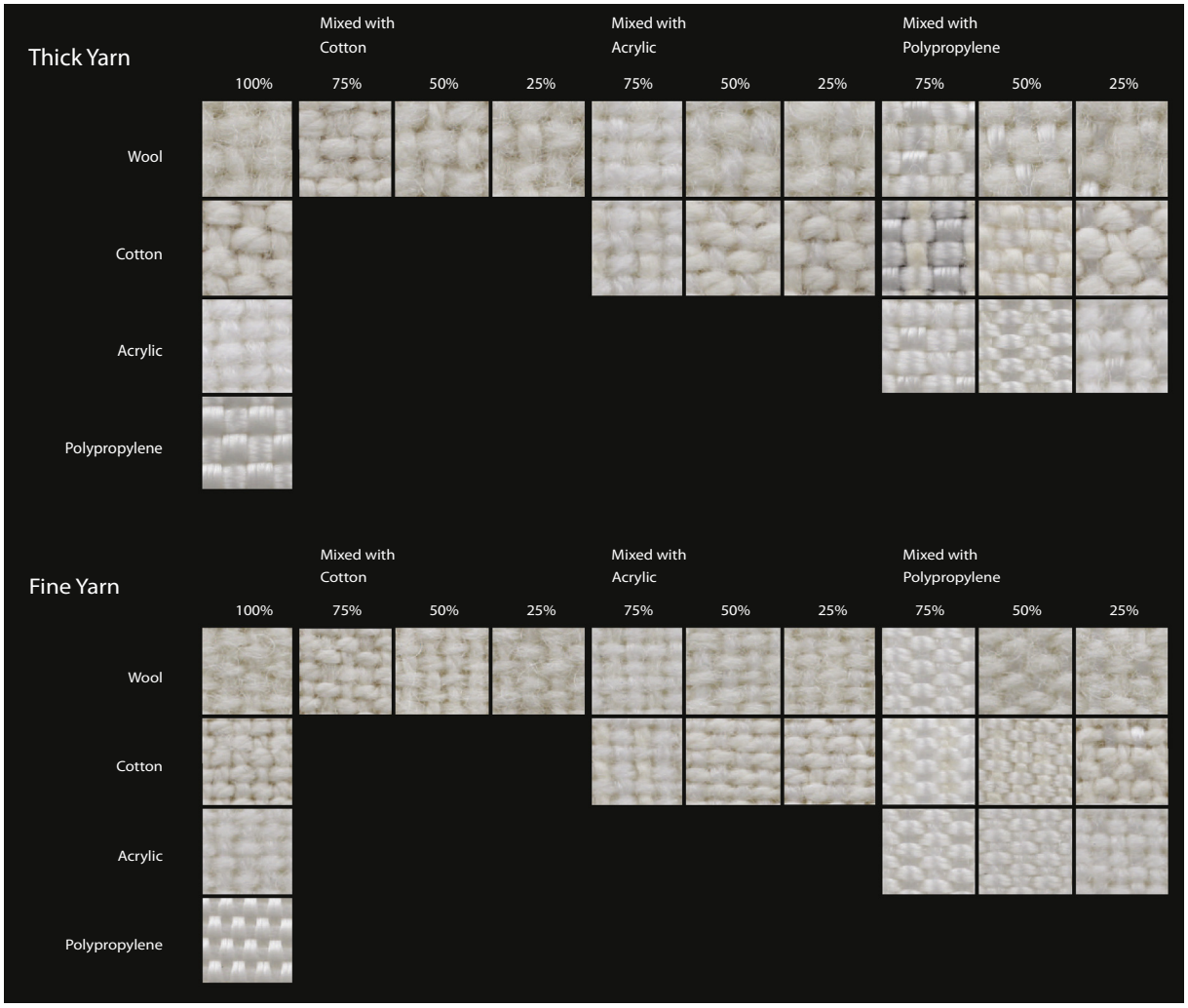

Fig. 2. A schematic overview of the stimuli. In the top panel the stimuli with a thick yarn and in the lower panel the stimuli with a fine yarn are shown. On the left side of each panel the pure materials (100%) are depicted. The other stimuli are the mixtures of two different materials (25–75%, 50–50%, 75–25%).

to reveal a high degree of inter- and intra-individual consistency after normalization.

2.4.3. Binary decision (BD)

The participants were asked to judge whether they think a stimulus is natural or not. They simply responded with a "yes" or a "no". We assigned the value 0 to the answer "no", and 1 to "yes" and averaged these values over all participants for each sample.

2.4.4. Ranked ordering (RO)

Participants were asked to rank the samples from most to least natural. They were handed the samples one by one in a randomized order and were asked to place them in a line on the table. The participants could change the order of the stimuli at any time during the task. After they reached their final ranked order, the samples were assigned the rank number corresponding to the position in the line (between 1 and 30). We averaged the scores for each sample and rescaled the results (from 0 to 1) to make the scores comparable to the other methods.

2.4.5. Analysis

In order to check the measurability of naturalness in textiles we correlated the four different measurement methods at the sample level. We found very high correlations between the methods (LS-ME: $r^2 = .96$; LS-BD: $r^2 = .95$; LS-OR: $r^2 = .93$, ME-OR: $r^2 = .96$, ME-BD: $r^2 = .95$, OR-BD: $r^2 = .92$), suggesting that we were actually measuring the same underlying construct. We could therefore average the data of the different measurement methods for each participant in order to get one value for naturalness for each participant, exploration modality and sample.

3. Results

3.1. One-material textiles

A Repeated Measures ANOVA with factors 'material' (4 levels: cotton, wool, acrylic and polypropylene), 'coarseness' (2 levels: fine and thick), and 'exploration modality' (3 levels: vision, touch and visuo-tactile) on the naturalness estimations revealed main effects of material, $F(3,93) = 348.47$, $p < .0001$, $\eta_p^2 = .92$, and coarseness (fine is rated less natural than thick), $F(1,31) = 25.58$, $p < .0001$, $\eta_p^2 = .45$, but not of modality. We found significant interactions between material and modality, $F(6,186) = 8.24$, $p < .0001$, $\eta_p^2 = .21$, material and coarseness, $F(3,93)$, $p < .05$, $\eta_p^2 = .15$, and between modality and coarseness, $F(2,62)$, $p < .05$, $\eta_p^2 = .10$. The average naturalness estimations averaged over exploration modality for pure wool, cotton, acrylic and polypropylene are shown in Fig. 3.

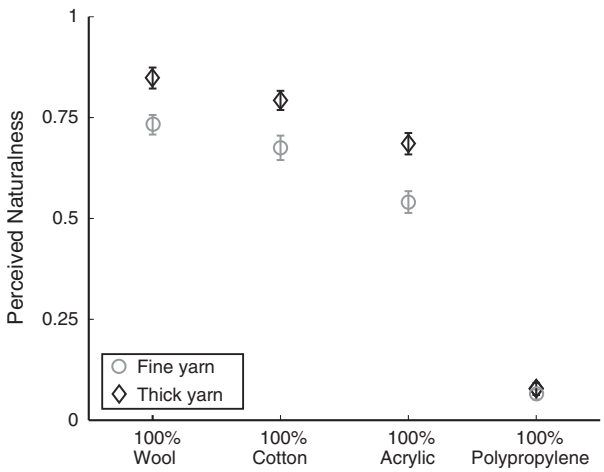

Fig. 3. Results for the pure materials. The diamonds (thick yarn) and circles (fine yarn) represent the mean naturalness estimations. The error bars represent the standard error of the mean over the participants.

Post-hoc paired samples *t*-tests revealed a difference between a thick and a fine yarn in wool, cotton and acrylic, but in the visual (wool, cotton, acrylic) and visuo-tactile (cotton, acrylic) exploration modes only (all $t_{df=31} > 3.27$, all $p < .004$, Bonferroni corrected α-level for multiple testing). Interestingly, no differences were found for tactile only exploration and no difference at all for polypropylene. Post-hoc paired samples *t*-tests revealed significant differences between almost all material comparisons (all $t > 3.17$, all $p < .001$, Bonferroni corrected α-level), except for cotton–wool (all modalities, both yarns) and cotton–acrylic (touch only, both yarns) and wool–acrylic (touch only, both yarns).

3.2. Mixed-material textiles

Next we analyzed the influence of the different material mixtures on the perception of naturalness by running a Repeated Measures ANOVA with factors 'material mixture' (6 levels: wool–cotton, wool–acrylic, wool–polypropylene, cotton–acrylic, cotton–polypropylene and acrylic–polypropylene), 'percentage' (3 levels: 75–25%, 50–50% and 25%-75%), 'exploration modality' (3 levels: vision, touch, visuo-tactile) and 'coarseness' (2 levels: fine yarn and thick yarn). We found main effects for material mixture, $F(5,155) = 306.92$, $p < .0001$, $\eta_p^2 = .91$, coarseness, $F(1,31) = 36.54$, $p < .0001$, $\eta_p^2 = .541$ and percentage, $F(2,62) = 199.28$, $p < .0001$, $\eta_p^2 = .86$. No main effect was found for modality. We found the following significant interaction effects: mixture ∗ coarseness, $F(5,10) = 3.03$, $p < .05$, $\eta_p^2 = .09$, mixture ∗ modality $F(10,310) = 6.54$, $p < .001$, $\eta_p^2 = .17$, mixture ∗ coarseness ∗ modality, $F(10,310) = 2.45$, $p < .05$, $\eta_p^2 = .07$, mixture ∗ percentage, $F(10,310) = 59.49$, $p < .001$, $\eta_p^2 = .66$, mixture ∗ coarseness ∗ percentage, $F(10,310) = 4.98$, $p < .001$, $\eta_p^2 = .14$, modality ∗ percentage, $F(4,124) = 6.06$, $p < .01$, $\eta_p^2 = .16$, mixture ∗ modality ∗ percentage, $F(20,620) = 3.36$, $p < .001$, $\eta_p^2 = .10$. The average naturalness estimations, averaged over exploration modality, are shown in Fig. 4. In Fig. 5 we show the two natural–synthetic mixture samples that were perceived as most natural: wool–acrylic (75–25%) and cotton–acrylic (75–25%).

4. Discussion

In this study we explored the perception of naturalness of textiles by creating 44 samples assessed by 32 participants. We investigated the perception of naturalness in pure and mixed materials (e.g. 50% polypropylene–50% cotton vs. 25% polypropylene–75%cotton), created with a fine or a thick yarn, and with the use of three different exploration strategies: vision only, touch only and by the use of both modalities. The main findings of the study are discussed below.

4.1. Pure vs. synthetic vs. mixed textile materials

As can be seen clearly in Figs. 3 and 4, polypropylene is perceived the least natural textile material. When materials are mixed with polypropylene, the perceived naturalness is partly or even completely destroyed. Unexpectedly, acrylic when mixed with the natural materials does not lower the perceived naturalness significantly, with respect to its natural counterparts. We therefore argue that acrylic may well be a good replacement for or addition to natural materials. According to Rozin [27] mixing two materials should result in even lower perceived naturalness values. Interestingly, the findings of the study show that mixed materials are not always perceived as less natural than the components of the mix. Our study showed that the wool textiles are perceived as the most natural materials. This can possibly be explained with the 'unique' and 'easily' recognized aesthetic qualities of wool compared to cotton which can be easily imitated by synthetic materials.

Another point to keep in mind is the durability and pilling of (acrylic) fibers, which may significantly affect how materials are perceived over time. Pilling concerns the formation of small balls of fibers on the surface of a textile. Most fabrics pill to some extent, although fibers such as linen and silk pill are less prone to pilling than other materials Fibers such as wool, cotton, polyester, nylon and acrylic seem to pill the most. However, in wool the effects of pilling diminish over time as the "wool-pills" simply fall off, whereas pilling in synthetic textiles is a more serious problem, because the stronger fibers prevent the pills from falling off [31]. The cause of pilling can be found in a variety of reasons: the physical characteristics (e.g. original material or amount and way of processing), but also the habits of the user of the material and the circumstances under which the material is used [39].

Even though pilling, wear and tear has been the focus of industry research for decades (e.g. [12], the problem remains and it can seriously compromise a textile's acceptability for consumers. As argued by many scholars in the domain of material design, if a material ages gracefully the material becomes personal and increases its relevance and value to an individual (see for example [6,35,26,10]. This might positively affect the formation of an emotional bond with that material and the product [30]. How a particular textile will tear and wear, how it will look and feel when it wears, when 'pilling' starts, should be taken into account in designing with textiles. Keeping 'graceful aging' in mind, designers may find ways to circumvent these kind of problems and come up with innovative designs which embrace wears and tears in product made of textiles. For example, "*Underskog*" (by Norwegian designer Kristine Bjaadal), is a chair which has a hidden pattern that is slowly revealed as the velvet fabric is being worn over time (Fig. 6).

4.2. Type of yarn

Similar to our predictions, a thick yarn is perceived as more natural than a fine, in both mixed and pure materials. When we consider that a thick yarn elicit a 'rough' tactile experience, this finding sheds more light on our initial findings presented in earlier publications (see for instance [18,22]). To our knowledge, this is the first time that it is shown that coarseness or thickness of the yarn of textile influences the perceived degree of naturalness. The finding that this is the case for all materials except polypropylene is easily explained by the idea that the presence of polypropylene destroys the perceived naturalness of a material, so that a difference

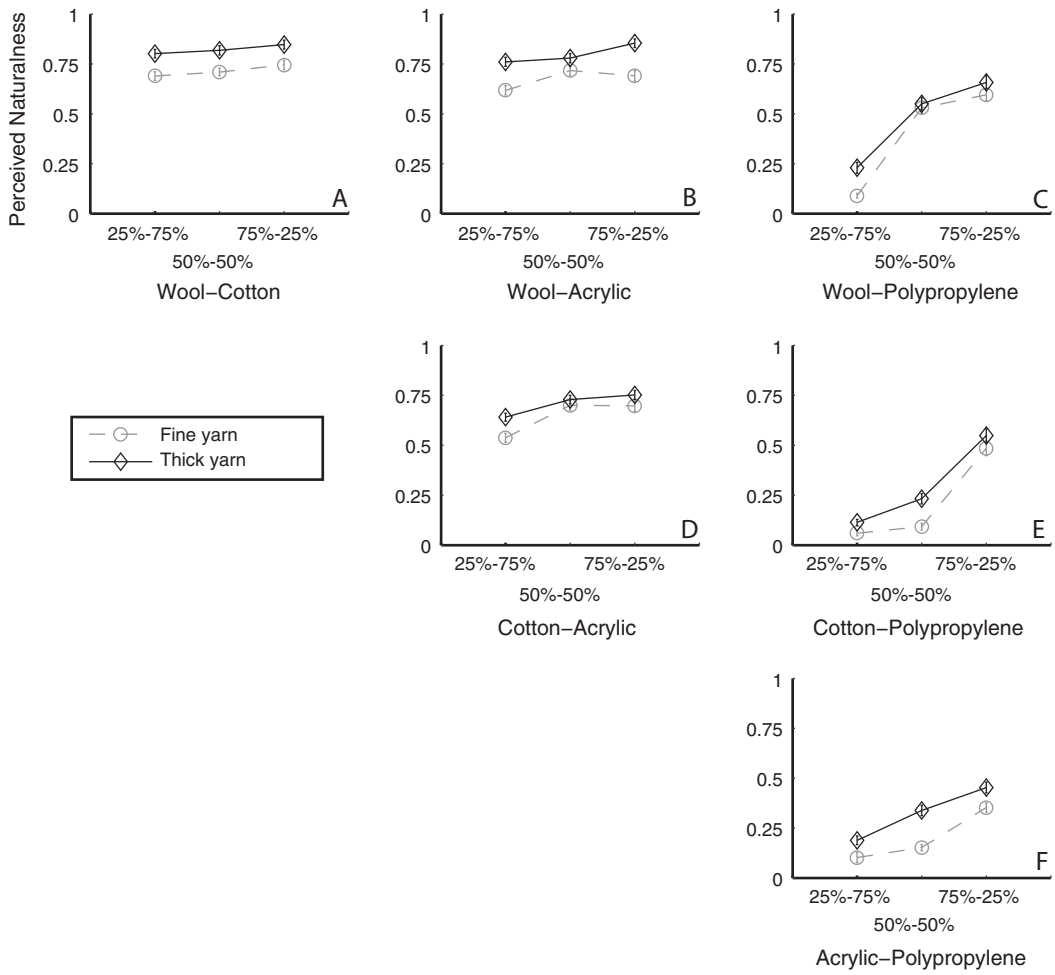

Fig. 4. Results for the mixed materials. The diamonds (thick yarn) and circles (fine yarn) represent the mean naturalness estimations. The error bars represent the standard error of the mean over the participants. Figure A–F represent the different mixtures that were used in the experiment.

Fig. 5. The two natural-synthetic mixture samples that were perceived most natural: in the left panel: cotton–acrylic–coarse yarn (75–25% mixture; 75.2% perceived naturalness), in the right panel: wool–acrylic–coarse yarn (75–25% mixture; 85.4% perceived naturalness).

between fine and thick yarn is not relevant for naturalness anymore. The effect of yarn thickness is interesting because it reveals a property that is orthogonal to the actual natural origin of materials which has, nevertheless, a psychological correlate for the perception of naturalness. Hence, its manipulation in synthetic or mixed fabrics can yield increases in the perception of naturalness without variations in the actual materials.

4.3. Sensory modality used in assessing the textiles

We hypothesized that how we interact with textiles – touch vs. vision, or touch with vision – may have had an influence on the perceived degree of naturalness. However, our results showed otherwise. Participants rated naturalness of the textile quite similarly in each modality and no significant main effects were found).

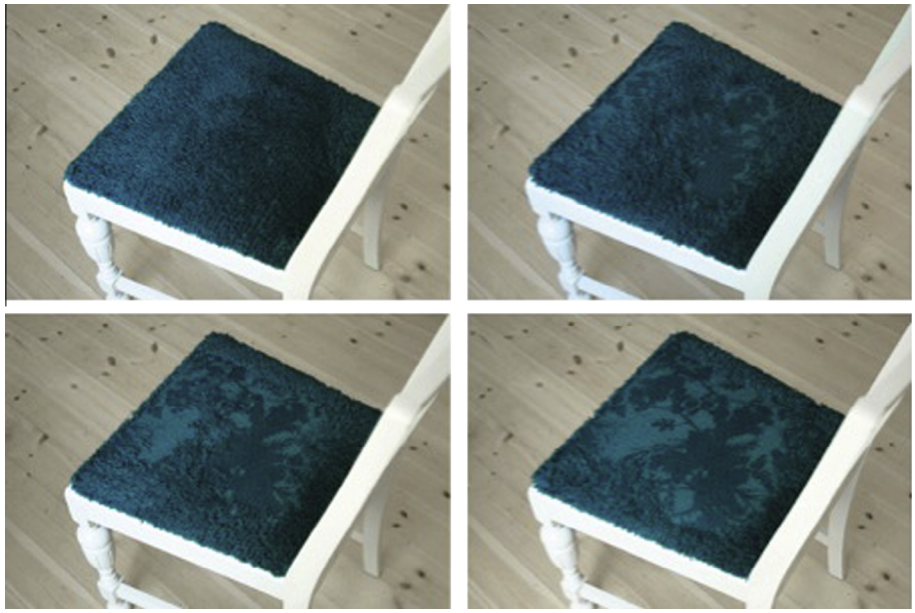

Fig. 6. "Underskog" is a chair which has a hidden pattern that is slowly revealed as the fabric is degrading, designed by Kristine Bjaadal (http://www.kristinebjaadal.no/portfolio/underskog/).

A possible reason behind this finding might be the way we presented the textiles. By mounting the textile samples in a box, we kept most external factors constant over the participants, but we excluded a few characteristics that may be important for evaluating naturalness in textiles through touch or vision: e.g. the way it moves or the amount of transparency. However, it could also have been the case that the key sensory features for naturalness estimation are multisensory (they can be assessed by both touch and vision, e.g. texture). Another possibility is that some of the key features to naturalness could be unisensory, but highly correlated across vision and touch (e.g. glossiness and smoothness), rather than completely independent (i.e., color or thermal properties). Along those lines, e.g. Yenket et al. [40] found no effects of – the visual characteristic – color on the perception of several tactile properties of fabrics (e.g. thermal properties, friction, stretch and softness). However, we do think that the influence of exploration modality should be explored in more detail in future studies and cannot be generalized at this moment, although they do confirm earlier results on naturalness estimations in wood samples [22].

4.4. Future directions

Expressing 'naturalness' in designing with materials will be increasingly important in nearby years, particularly centralized on the discourses of sustainability. With this paper, we aim to shed light on the essentials of expressing naturalness in textiles, which we believe will support (textile) designers when the aim is to express naturalness in design. Although Dacremont and Soufflet [7] found that knowledge about the end-use of fabrics (e.g. to make dresses or to make sportswear) did not have influence on how participants sorted different types of fabrics according to their tactile similarities, we argue that when textiles are used for garments or bed sheets, the way we interact with these materials is very different from the current form of exploration. One of the remaining questions is: How would those positively rated textile samples be perceived when applied in products and when used? We suggest these aspects to be explored further in follow-up studies.

5. Conclusion

We explored three aspects as variables and their effects on the appraisals of textile materials as natural: natural vs. synthetic vs. mixed materials, type of yarn and exploration modality. Our main objective was to show when properly combined with pure (inherently natural) materials, synthetic materials may have the great potential to be perceived as natural as inherently natural materials. This can broaden the possibilities in design for sustainability such that the products made of such mixed materials will be more durable than 100% natural (pure) materials, which will certainly be less harmful for the use natural sources, and will be perceived as natural as originally natural materials, hence will be preferred by consumers. We showed that mixtures with acrylic materials could be better alternatives to 100% wool and cotton, especially when using a thick yarn. Possible applications would be garments or other textile designs in which the natural look is prerequisite.

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