1. INTRODUCTION

Sweden and Japan are referred to as leading forest countries because forests occupy approximately two-thirds of the land area in each country [1]. Both cultures use wood to make furniture. In Scandinavian furniture design, beech, birch, pine, and alder are commonly used woods. Nina Bruun et al. from the company Muuto describe a “New Nordic” approach as an innovative new style for a traditional armchair in beech. Enforced plywood in beech challenge the transparent design and offers a “comfort” similar to the values of Scandinavian modern style [2]. Japanese furniture utilises simplicity, where linearity and asymmetrical patterns are important. Many rigid or monotonous linear designs are in fact “saved” from that asymmetrical structure [3]. Sweden and Japan both have wooden culture, although their impressions of wood are different. Nakamura et al. reported that wood panels with knotted surfaces gave impressions of “disordered”, “cheap”, “disagreeable”, and “ugly” for Japanese [4]. Conversely, Borman investigated the aesthetic properties of knotty wood surfaces based on people’s preference using 54 questions, with only Swedish participants. The result showed the degree of acceptance, harmony, and activity, which was then analyzed by principal component analysis; these parameters had high correlation. A balance between the degree of activity and the degree of harmony is important. A high degree of activity affects Swedish preference [5].

These reports show that the impression of wood is different, even though there are similar wooden cultures. Additionally, it is interesting to note that the characteristics of catalog images of wood specimens in Japan and Sweden are quite different (Figure 1) [6, 7]. There are many wooden products with visible wood knots as shown in the Figure 1 (left) in Swedish catalogs and Figure 2, but there are quite few wood knots in the Japanese ones. What is the reason for this difference? In this study, it is hypothesized that the emotional responses when evaluating wood differ between the Japanese and the Swedish, and this difference affects catalog images. It is assumed that wood knots cause differences not only in appearance but also in the texture of wooden products; that is, these knots influence both visual and tactile sensations. Therefore, to reveal differences in catalog images of wood and differences in human emotional response based on cultural background or nationality, we investigated the differences between the two countries with respect to furniture emotional response when assessing wood, focusing on tactile sensation and visual sensation.
2. MATERIALS AND METHODS

2.1 Materials [8, 9]

We used actual wood specimens in this research. Three species of Japanese wood and four species of Swedish wood were prepared as test specimens. The Japanese specimen comprised beech, Japanese cedar, and oak, and the Swedish wood included beech, birch, pine, and alder (Figure 3, Table 1).

- Beech is a hardwood with a white and light brown color. The grain is not clear, but there are dot patterns.
- Japanese cedar is a softwood with a light brown color. It is soft and easy to process. It has a clear, straight grain.
- Oak is a hardwood with a dim light brown color. It has a special silver-gray grain, Torahu, which looks similar to the markings on a tiger (Tora) pelt (See in Figure 2).
- Birch is a hardwood with a white and light brown color. It has a simple straight grain.
- Pine is a softwood with a yellow and light brown color. It has a clear straight grain.
- Alder is a hardwood with a light brown color. It has a clear grain and is easy to process. It also cracks easily and therefore is not used for chair legs.

The aim of this study is to investigate the differences customers perceive, and discuss possibilities for Japanese and Swedish woods for the future.

All test specimens were coated with three layers of urethane (top, middle, and under painting). The specimens were 280 mm × 280 mm × 10 mm squares. For each type of wood, two sets of specimens were prepared and used randomly.

2.2 Methods

The experiment to investigate differences in emotional responses was carried out over two days. Tactile sensation was assessed on the first day, and visual sensation was assessed on the second to avoid overlapping sensation effects when assessing the test specimens. We used the semantic differential method (SD method) as the sensory test on a 7-grade scale.

<table>
<thead>
<tr>
<th>Wood specimens Types</th>
<th>Color</th>
<th>Grain</th>
<th>Others characteristics</th>
</tr>
</thead>
<tbody>
<tr>
<td>Beech hardwood</td>
<td>white and light brown</td>
<td>not clear</td>
<td>dots pattern</td>
</tr>
<tr>
<td>Japanese cedar softwood</td>
<td>light brown</td>
<td>clear straight grain</td>
<td>soft and easy to process</td>
</tr>
<tr>
<td>Oak hardwood</td>
<td>light brown</td>
<td>special silver-gray grain, Torahu</td>
<td></td>
</tr>
<tr>
<td>Birch hardwood</td>
<td>white and light brown</td>
<td>simple straight grain</td>
<td></td>
</tr>
<tr>
<td>Pine softwood</td>
<td>yellow and light brown</td>
<td>clear straight grain</td>
<td></td>
</tr>
<tr>
<td>Alder hardwood</td>
<td>light brown</td>
<td>clear grain</td>
<td>easy to process</td>
</tr>
</tbody>
</table>

Figure 2: Wood grain and knot from Japanese cedar (left), and wood grain and Torahu, special grain from Oak (right)

Figure 3: Test specimens
The experimental procedure is shown in Figure 4. Participants entered the experimental room and were told about the test. On the first day, when performing the tactile perception test, a test specimen was set in a black box and participants put their hand into the black box and touched the test specimen without seeing the specimen. Participants sat on a chair and touched a specimen freely with their palm, but were prohibited from scratching and holding it. On the second day, when performing the visual perception test, a test specimen was set on a black table. Participants simply observed a specimen freely. The surface appearance may be changed as the participants moved around the room; therefore, instructions to keep the same seating style were given. Information about test specimens was the same in the tactile and visual parts of this sensory test.

Seven “actual” wood specimens were shown randomly to each participant, who were then asked to describe the tactile sensation and the visual sensation in four material terms (“cool/warm”, “rough/smooth”, “dry/moist”, and “hard/soft”) and four emotional terms (“uncomfortable/comfortable”, “cheap/expensive”, “artificial/natural”, and “dislike/like”). For example: extremely cool: -3, moderately cool: -2, slightly cool: -1, extremely warm: +3, moderately warm: +2, slightly warm: +1, and neither: 0.

After completing the sensory test, each participant wrote down their reasoning and opinions.

Statistical analysis was performed using the Excel statistical software package (Excel-Toukei 2012; Social Survey Research Information Co., Ltd.). The data were analyzed using 1-way ANOVA for each term for each nationality and sensation. Participants included 12 Swedish university students (M: 6, F: 6) and 12 Japanese university students (M: 7, F: 5). The temperature and relative humidity in the experimental environments were maintained at 22–23°C and 65% RH, respectively, and the experiment proceeded under a general lightning system.

3. RESULTS AND DISCUSSION

3.1 Assessing wood through tactile sensation

The results for the Swedish participants show that the SD profiles for each specimen were almost the same, which suggests that the Swedish participants were not able to differentiate wood based on tactile appraisal (Figure 5). From the ANOVA result (Table 2), participants were able to distinguish the material in terms of “cool/warm” and “rough/smooth”, especially for Japanese cedar and Japanese oak. Participants did not feel much difference in moisture or comfort.

<table>
<thead>
<tr>
<th>Impression</th>
<th>Tactile</th>
<th>Visual</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cool-Warm</td>
<td>*</td>
<td></td>
</tr>
<tr>
<td>Rough-Smooth</td>
<td>**</td>
<td>**</td>
</tr>
<tr>
<td>Dry-Moist</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hard-Soft</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Uncomfortable-Comfortable</td>
<td></td>
<td>*</td>
</tr>
<tr>
<td>Cheap-Expensive</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Artificial-Natural</td>
<td>*</td>
<td></td>
</tr>
<tr>
<td>Dislike-Like</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Figure 5: Results of tactile sensation test for Swedish (left) and Japanese (right) participants
For the Japanese participants (Figure 5), the SD profiles had a similar tendency to the results of the Swedish test subjects. Japanese participants differentiated between “rough/smooth” and “artificial/natural”, especially among Japanese cedar, Japanese oak, and other woods. The similar tendency was confirmed not only with the SD profile but also from the ANOVA results (Table 2). It was easy for the participants to feel and respond to the surface texture of the test specimens. When they touched the raised wooden surfaces, they described them as natural. Four Swedish woods and Japanese beech were described as “smooth”; therefore, these specimens gave an artificial impression to Japanese participants. Akiyama et al. [10] reported that it was not enough to decide impression for woody materials by visual sensation only. Japanese participants felt “natural” when haptic information assessing various woody floor materials was added. This occurred because embossed floor materials are often easier to recognize. Participants recognized only visual sensation in this result, whereas, it is clear that embossed materials can more easily be distinguished with tactile sensation. Akiyama et al. concluded that tactile information amplified participants’ feeling [10]. Therefore, assessments of “rough/smooth” and “artificial/natural” are related to each other and seem to be important tactile information for Japanese people.

Similar results regarding the tactile sensation test for both Swedish and Japanese participants were observed, and neither group could distinguish the specimen country of origin. When assessing “uncomfortable/comfortable”, “cheap/expensive” and “dislike/like”, the responses did not show any differences between test specimens. It appears that only providing tactile information is insufficient for participants to distinguish among the different test specimens.

3.2 Assessing wood through visual sensation

The results of the visual sensation assessment show that Swedish participants could easily assess the different test specimen parameters (Figure 6). From the ANOVA results (Table 3), participants distinguished between “rough/smooth”, “cheap/expensive”, and “artificial/natural” for each test specimen. Swedish birch and Swedish alder had similar results based on visual sensation assessment. Japanese oak and Swedish pine were described using the terms “comfortable”, “natural”, and “like”, and Swedish beech gave a “hard” visual impression. Visual features were effective for distinguishing these and assisted in the assessment because significant differences are more easily viewed than felt.

The result from the investigation of the aesthetic properties of knotty wood surfaces for Swedish had high correlation with the degree of acceptance, harmony, and activity [5]. Therefore, it seems that results indicate that knotty surfaces and distinct grain made a positive impression on Swedish participants.

A different trend was obtained from Japanese participants. They could distinguish between test specimens using visual sensation (Figure 6). From the ANOVA results (Table 3), it can be observed that participants could distinguish between “rough/smooth”, “hard/soft”,

<table>
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<th>Visual</th>
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</thead>
<tbody>
<tr>
<td>Cool-Warm</td>
<td>**</td>
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</tr>
<tr>
<td>Rough-Smooth</td>
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<tr>
<td>Dry-Moist</td>
<td>**</td>
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</tr>
<tr>
<td>Hard-Soft</td>
<td>**</td>
<td>*</td>
</tr>
<tr>
<td>Uncomfortable-Comfortable</td>
<td>**</td>
<td>*</td>
</tr>
<tr>
<td>Cheap-Expensive</td>
<td>*</td>
<td>*</td>
</tr>
<tr>
<td>Artificial-Natural</td>
<td>**</td>
<td>*</td>
</tr>
<tr>
<td>Dislike-Like</td>
<td>*</td>
<td>*</td>
</tr>
</tbody>
</table>

Table 3: Statistical analyses for sensory tests were performed with one-way ANOVA to examine the difference in Japanese participants’ impressions (tactile and visual) of test specimens. (*p<0.05, **p<0.01)

Figure 6: Results of visual sensation test for Swedish (left) and Japanese (right) participants
“uncomfortable/comfortable”, “cheap/expensive”, and “dislike/like” for the test specimens. Participants used “comfortable” and “like” to describe the Swedish wood specimens. Japanese participants also reported that Swedish wood gave them a feeling of smoothness and softness.

Nakamura investigated visual inducement of knots on wood wallpaper and reported that wood panels with knotted surfaces gave the impression of “disordered”, “cheap”, “disagreeable”, and “ugly”. This result suggests that Japanese are sensitive to wood knots and grain [4]. It seems that the Japanese focus on these easily and thus have a negative impression of such specimens. Therefore, it is assumed that the Japanese impression of the wood was mostly based on outstanding, negative characteristics. This means if there is a special grain, they focus on only the grain and ignore other elements, basing the overall impression on the color or the harmony of the knotted or unusual surface.

The results of visual sensation had few similar points between Swedish and Japanese participants. Swedish beech, Swedish birch, and Swedish pine were assessed as “smooth” by both the Swedish and Japanese. It is assumed that this description was influenced by wood color and grain. The aforementioned specimens are white and light brown and do not have unusual grain. Their surface appearance gave an impression of smoothness to both groups of participants.

In contrast, the scores between the Swedish and Japanese were quite different, especially those for Swedish wooden specimens, except when assessing “rough/smooth” (Figure 6). Swedish are used to seeing Swedish wood, so they are able to distinguish them. Japanese are not used to seeing these and cannot distinguish these Swedish woods because Swedish woods have similar colors and no grains. Additionally, the color of Swedish wood is light. These colors gave a warm impression [11]. Japanese were pleased with Swedish wood that has a plane surface appearance. Japanese participants obtained these homogeneous and warm impressions as a common impression of Swedish wood. Therefore, as mentioned before, they could not distinguish but felt “warm”, “smooth”, “soft”, “comfortable”, “expensive”, and “like”. The Japanese provided opposing opinions: “cool”, “rough”, “hard”, “uncomfortable”, “cheap”, and “dislike”. This is because Japanese oak has a special silver-gray grain, Torahu. Both sets of participants reported that it felt “natural”, but Torahu, the distinct grain, gave a different impression to each group. For the Swedish, it may be that Torahu is just a kind of grain. It may be true that, as Borman mentioned, there is a knotty wood effect [5], so that when evaluating the visual impression of wood, the Swedish felt “like” for Japanese oak. However, Japanese wood panels with knotted surfaces gave the impression of “disordered”, “cheap”, “disagreeable”, and “ugly” for Japanese because these knots gave an impression of inhomogeneity [4]. We suggest that this different impression of special grains may be responsible for the different characteristics of catalog images. A knot is a defect of wood, but people perceive that as one of the particular characteristics of surface appearance; for some people from Japan a knot gives the impression of a “simple material” [12]. The grain is also a particular characteristic of surface appearance, and consumers tend to like these types of wood [8]. In this research, there was no knot on the test specimen’s surface, and it is suggested that the special surface appearance, particularly knots and grain, influence the visual impression.

The tactile sensation or visual sensation was compared, although the results of both visual-tactile sensation were not focused on in this study. It is inferred that the tendency of the results and formation of the visual-tactile impression were different. It is suggested that Swedish were influenced by the visual impression from the current study and Japanese were more influenced by the tactile impression from another research [10].

![Figure 7: Results of sensory test with Japanese oak using tactile (left) and visual sensation (right)](image-url)
There were different impressions between Swedish and Japanese people with each perception. This result can be applied to a marketing strategy for wooden furniture, which we discuss in the next section.

3.3 Opportunities to market Japanese wood products in Sweden

In both Japan and Sweden, the forest is a significant asset, where wood products like furniture constitute an important part of the industry. Japan and Sweden are also countries where design plays a major role, with many similarities in terms of design and products. This fact should allow companies from Japan to market and sell products in Sweden, and vice versa. Hakala et al. (2015) reports that young consumers in Germany and Finland find wooden furniture aesthetic, ecological, durable, and expensive. Their study showed also that price, visual appearance, and quality are the key attributes of preferred furniture products in both countries, followed by ecological aspects and functionality [13]. A prerequisite for marketing wooden products in Scandinavia is that Japanese furniture manufacturers embrace the needs and tastes of the Swedish consumers in terms of design. The results of this study show that there are differences in the perception of wooden products, but this knowledge makes it possible to adapt the product to the market and the consumer in the particular country, in this case Sweden or Japan.

3.4 What is required for Swedish wood products to attract Japanese consumers?

In each country and market, it is important to adapt and connect products to the actual taste and needs of consumers. If the consumer’s feeling could be implemented in the new product, he/she would be more satisfied in the buying process and hopefully buy the actual product [14]. Kansei engineering is according to M. Nagamachi an individual participative artefact, environment, or situation where all senses, including smell, hearing, taste, and sight, are used [15]. To achieve success for wood products as furniture and floor products in the Japanese market, it is a good idea to implement knowledge and tools from Kansei engineering. Previous studies have shown enhanced market achievement after applying the results of actual Kansei product studies.

As described earlier in this paper, Japanese participants in this study perceived Swedish woods and Japanese beech as artificial because they were “smooth”. This kind of knowledge can be used for example in furniture design to make the surface of the wood more “rough” and thus attract Japanese consumers with a more natural feeling for the specific product. A significant observation from the results of this study is that Japanese oak and Swedish pine are considered “comfortable” and “natural”, and Swedish beech gave a “hard” visual impression. This was detected mostly by the visual tests, where the test subjects visually inspected the specimens and made their comments. This strengthens the belief that significant differences are more easily viewed rather than felt.

3.5 Wood products, consumer perception, and Kansei engineering

The fact that Swedish and Japanese consumers have different opinions about different types of wood can be seen as natural. The countries are located in different parts of the world, geographically far apart, but they are also countries with major historical and cultural differences. Cultural differences between Europe and Japan regarding religion, art, music, performing arts, and crafts have been reported [16].

Currently in Japan, North European design for furniture is popular. It is assumed that the calm and warm color and simple design influence and resonate with Japanese Kansei. How about the opposite part; Swedish Kansei for Japanese design? The trend in Sweden is that Japanese design is up-and-coming. As an example, a Japanese fashion and design company opened their first store in Sweden in August 2018. The Japanese wood specimens gave a positive impression to Swedish people, even though the Japanese wood possessed a negative image for Japanese people because of the strong surface appearance. This result means that the Japanese design can be spread around the world, the same as North European design. There are many non-used wood materials in Japan waiting to be used by the industry. Here is an opportunity to spread wood design from Japan also to Sweden and other countries. Hopefully, such a promotion can revitalise the Japanese furniture market.

The similarities in terms of taste within product design with minimalism and a restrained expression should not be underestimated. This opens up opportunities and new markets for industry in both these countries if knowledge of these similarities and differences can be utilised in a sensible manner. This is largely true for the wood and furniture industry, a major industry in both Japan and Sweden.

This study shows that opportunities exist but that much work remains to find out more about the market conditions for more specific product types. Kansei engineering can be a tool in continued research in this area.
4. CONCLUSIONS

This study investigated human emotions across two different nationalities, for two sensations: tactile and visual. There were similar tendencies for each wood specimen for both Swedish and Japanese participant groups, and that is common between Swedish and Japanese. It was difficult to assess the wood specimens using only tactile sensation, except for Japanese cedar and Japanese oak. However, there were differences in visual assessment results for wood specimens between Swedish and Japanese participants, which were especially influenced by grain appearance. Swedish prefer wood with a balance of activity and harmony. If there is a special grain, they focus on not only the grain but the harmony including these grains. Japanese generally focus on the wood grain, and if they perceive inhomogeneity, they are more likely to dislike the wood. Therefore, a catalog from Sweden has many wood products with grains, whereas a catalog from Japan does not.

It can be a good idea to choose wood with varying surface appearance for Swedish customers. Japanese could not distinguish wood with similar color and plane surface appearance. Japanese wood has clear grain and various colors. These are effective for making a positive impression and suggest that this wood has a chance of being accepted by Swedish people, just as Scandinavian wood and design have been accepted by the Japanese.

In both Japan and Sweden, the forest is a significant asset, where wood products constitute an important part of the industry. This paper focused on how to capture and understand the characteristics and surface appearance. Swedish people like accent warm colors in a room to keep them happy, but it seems that Japanese prefer the “original” characteristics of the material, as Japanese consider “we are part of nature” and feel beauty from being coexistent and harmony with nature [17]. The preferred characteristics include basic patterns and homogeneity. One of the reasons for this may be the difference in culture associated with the fact that the two countries are located in different parts of the world. An understanding of these differences can open up new markets for industry in both countries.

Further studies are needed to focus on not only distinct tactile and visual sensations, but also tactile-visual sensation, with further comparison of the three.

Additionally, these results can be helpful for catalog makers. The comment: “change the surface appearance” is an important point to focus on in the future. Here, the technology and skills are important factors to show the grains in the wood from different positions and in different light. The investigation of Kansei is a good focus point for the catalog company.

A suggestion for future work is also to apply a marketing strategy for wooden furniture with the theory of marketing. The “marketing mix” has a crucial role in differentiating a product’s unique quality from its competitors. This mix (4P: price, product, promotion, and place) can guide manufacturers to new market opportunities for wood in Japan and Sweden.

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