WOOD RESEARCH
56 (4): 2011
455-466

PSYCHOLOGICAL AND EMOTIONAL REACTIONS TO ANATOMICAL PATTERNS IN WOOD

Sha Sha Song, Guangjie Zhao
Beijing Forestry University, College of Materials Science and Technology
Haidian, Beijing, China

(Received January 2011)

ABSTRACT

The present study aims to discover the visual impression and comprehensive evaluation of the three-section anatomical patterns in wood, further positioning these psychological variables in sense, emotion and evaluative dimensions, make these natural patterns can better use and lay a foundation for applying to industrial design and decorative design of pattern texture. Based on the visual perception of 50 subjects on the microstructure patterns of 18 species of trees in Northeast China, Questionnaires and Semantic Differential (SD) method are used to measure and discuss the emotional and psychological expression of wood microstructure patterns. The results show that: In the sensorial dimension, for the transverse section, softwood is fine and smooth but hardwood is rather rough and loose; for the radial section, softwood is smooth and soft while hardwood is slightly rough and hard; for the tangential section, softwood is rather flat and straight whereas hardwood is bump and curving. In the emotional dimension, softwood's transverse section makes people feel calm and pleased, while hardwood's transverse section in moderate regional and sometimes even irritates people; softwood's radial section is mellow and pleasing, but hardwood gives people a strong feeling and makes them feel uncomfortable; the tangential section of softwood and hardwood both impress people with its free beauty; softwood is thought to be beautiful but most of the hardwood is not. In the evaluative dimension, for the transverse section, softwood and most of the hardwood produce a compact and natural feeling; for the radial section, most softwood leaves a concise and exquisite impression, but hardwood gives a complex and inelegance impression; for the tangential section, although softwood's patterns are slightly regular, and hardwood's are a bit messy; both can be used for decoration.

KEYWORDS: Wood anatomical structure patterns, emotion, psychological feeling.

INTRODUCTION

The three-section microscopic anatomical structure creates various patterns of wood. The cells of wood–ray, parenchyma and pores, with irregular changes and order in some degree, form natural patterns, giving people the psychological feeling of changing, moving and living. The correlation research also suggests that the fluctuation spectrum of wood's cellular structure shares the same existence form with human body's physiological rhythm (Zhao 1997).

So far, certain progress and achievements have been made by Chinese and foreign scholars in the visual psychology of wood's macro surface texture and its environmental characteristics (Yamada 1987, Nakamura and Takachio 1960, Nakamura and Masuda 1995, Masuda 1992, Nakamura et al. 1996, Liu et al. 1995, Liu 1994, Liu et al. 2003, Yu et al. 2004). Still the research on the visual characteristics of wood's micro structure and the role of emotion is rare. Intuitive and visual senses don't confine to wood's surface, but further into its internal hidden structure. The visual sense of wood's microscopic structure patterns reflects people's feelings deep down and complicated psychological, physical responses; different micro-structure of wood gives people different psychological and physical feelings, thus creating different feelings. This study tries to measure the conversion of the visual physical characteristics into the psychological characteristics by observing the microstructure patterns of 18 species of trees in Northeast China, positions wood's three-section microscopic anatomical structure patterns in the sensorial, emotional and evaluative dimension, and provides reference for artistic expression of wood texture and product design.

MATERIAL AND METHODS

Materials selection and subjects

50 subjects (25 male, 25 female) with the average age of (26±1) years and related and irrelated wood science professional background (undergraduate, postgraduate, teacher) were selected to observe the three-section (TR: Transverse section, RA: Radial section, TA: Tangential section) anatomical patterns (Fig. 1) of 18 selected species of trees in Northeast China (Tab. 1). In order to minimize the influence of color on wood's Kansi images, the selected images of wood, with equal size, are grey processed, and each slide of image was presented for 10 seconds for every subject to watch.

Tab. 1: Wood specimens used for study.

Species	Code	Scientific names
SOFTWOOD		
Korean pine	KP	*Pinus koraiensis* Sieb. et Zucc.
Dahurian larch	DL	*Latix gmelini* (Rupr.) Rupr.
Mongolian scotch pine	MP	*Pinus sylvestris* L. var. mongolica Litven.
Khingan fir	KF	*Abies nephrolepis* (Trautv.) Maxim.
Stiffleaf juniper	SJ	*Juniperus rigida* S. et Z.
Japanese yew	JY	*Taxus cuspidata* Sieb. et Zucc.
HARDWOOD		
Asian white birch	WB	*Betula platyphylla* Suk.
Ussuri poplar	UP	*Populus ussuriensis* Kon.
Dahurian buckthorn	DB	*Rhamnus dahuricus* Pall.
Manchurian ash	MA	*Fraxinus mandshurica* Rupr.
Mongolian oak	MO	*Quercus mongolica* Fisch. et Turcz.
Siberian elm.	SE	*Ulmus pumila* L.
Manchurian Walnut	MW	*Juglans mandshurica* Max.
Chinese wing-nut	CW	*Pterocarya stenoptera* C.DC.
Chinese heartleaf hornbeam	CH	*Carpinus cordata* Blume.
Mono maple	MM	*Acer mono* Maxim.
Amur maackia	AM	*Maackia amurensis* Rupr. et Maxim.
Black locust	BL	*Robinia pseudoacacia* L.

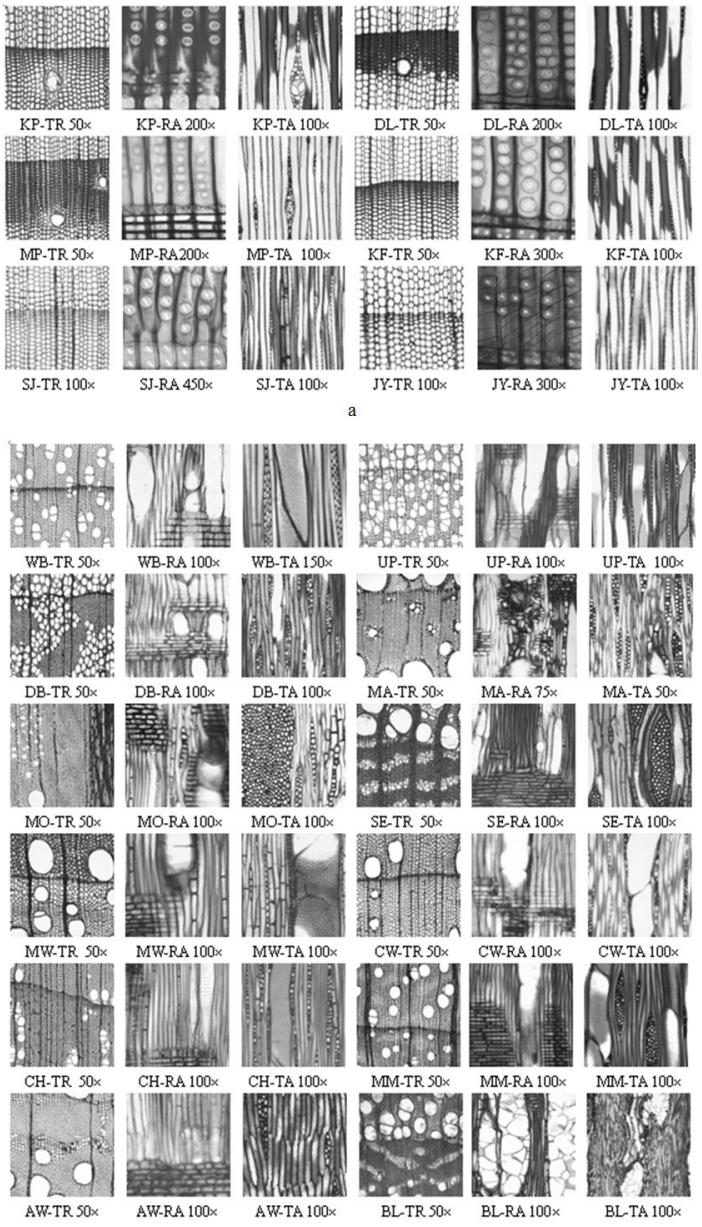

Fig. 1: The anatomical structure patterns of 18 species of wood a) softwood, b) hardwood.

Because of the anatomy in wood is regarded as geometrical patterns, therefore the cell tissue

composition of three-section in visual field should be complete. So softwood's transverse section magnification is 50x to 100x, radial section is 200x to 450x, and tangential section is 100x, hardwood's transverse section magnification is 50x, radial section is 75x to 100x, and tangential section is 50x to 100x. In order to minimize the influence of color on wood's Kansi images, the selected images of wood, with equal size, are grey processed, and each slide of image was presented for 10 seconds for every subject to watch and selected.

Microscopic structure patterns measurement of sensory characteristics of wood

100 pairs of Kansei image semantic glossary were collected from websites, books, journals, dissertations on wood science and psychology or obtained from interviews and questionnaires. Subjects, according to their subjective feelings, chose 40 pairs Kansei terms from the glossary pairs (each pair with one positive and one negative) on the questionnaire, which can best describe the micro-structure patterns of wood.

The experiment was based on the special relationship among visual sense, thought and psychological response. According to the visual sensory stimulation and psychological reactions on patterns of wood microscopic cell-piled structure, the glossary was grouped into three dimensions (sensorial, emotional, and evaluative). Subjects were asked to select 40 pairs of Kansei words according to their feeling, and fill them into four quadrants of the three dimensions as it is shown in Tab. 2.

Tab. 2: Results of typical semantic differential bipolar adjective in the micro tri-sectional anatomical patterns of wood in 3 dimensions of clustering.

Project	Sensory	Emotional	Evaluation
Transverse section	smooth—rough fine—loose	please—dislike calm—irritate	natural—artificial compact—incompact
Radial section	smooth—rough soft—hard	mellow—strong please—dislike	exquisite—inelegance concise—complex
Tangential section	flat —bump straight—curve	beauty—unsightly free—sedulously	regular—messy practical—decorate

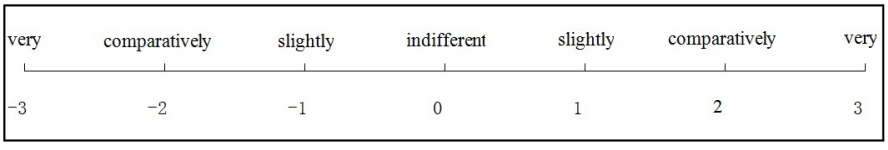

Fig. 2: Semantic differential rating scale.

Semantic Differential Method (Hsu et al. 2000, Dalton et al. 2008) was used to make seven-step (+3~ -3) semantic differential rating scale (Fig. 2), which consists of wood's microscopic images and perceptual semantic glossary, each rating scale is 1. The survey was carried out in the wood science laboratory where subjects sit still, watch PowerPoint slides, and give their evaluation according to their psychological feeling.

RESULTS AND DISCUSSION

Evaluation and analysis of sensory, emotional, evaluative dimensions for anatomical patterns of transverse section in wood

Fig. 3 is the quadrant distribution state of sensorial, emotional, evaluative dimensions for anatomical patterns of wood's transverse section. For the softwood's transverse section, from Fig. 3-1: The sensorial dimension, we can see that Korean pine, Khingan fir, Stiffleaf juniper, Dahurian larch and Mongolian scotch pine all locate in the "smooth & fine" quadrant, the earlywood and latewood trachieds of Mongolian scotch pine's transverse section look smaller than any other wood's and their shapes change slowly and tend to be fine and close; the cells of Khingan fir are much bigger with rectangular shape which changes slowly and tends to be smooth; the Japanese yew locates in the quadrant of "smooth & loose", due to the fact that its cells shape like big polygon and stack regularly, therefore, the cell-piled structure patterns look a bit coarse and loose.

From Fig. 3-2: The emotional dimension, we observe that Khingan fir, Stiffleaf juniper, Japanese yew, Korean pine, Dahurian larch and Mongolian scotch pine all locate in the "please & calm" quadrant. As the Stiffleaf juniper's cells stack more regularly, it makes people feel calm; the cell structure patterns of Korean pine's irregular oval resin duct and pores are unique, thus looking more pleasing.

From Fig. 3-3: The evaluative dimension, we know that Khingan fir, Stiffleaf juniper, Japanese yew, Korean pine, Dahurian larch and Mongolian scotch pine all locate in the "natural& compact" quadrant. The cells of Mongolian scotch pine stack rather close, so its piled-structure patterns look more compact. As Dahurian larch's cells shape differently with obvious rank trend, Dahurian larch is thought to be more natural.

For the hardwood's transverse section, from Fig. 3-1, the sensorial dimension, it can be seen that most hardwood distribute in the quadrant of "rough & loose", because of radical or echelon structure of the pores, Ussuri poplar tends to loose. However, with small, moderate quantities and scattered order of the pores and solitary axial parenchyma, Chinese heartleaf hornbeam presents fine property.

From Fig. 3-2: The emotional dimension quadrant, it can be seen the transverse section patterns of most hardwood trend towards irritable psychological feeling which caused by the pores and the order of the parenchyma of earlywood and latewood.

From Fig. 3-3: The evaluative dimension, the visual evaluation of most hardwood distribute in the "compact & natural" quadrant. With the numerous quantities of the pores and larger than ambient cells, the order of Ussuri poplar tends to be loose.

Evaluation and analysis of sensory, emotional, evaluative dimensions for anatomical patterns of radial section in wood

Fig. 4 is the quadrant distribution state of sensorial, emotional, evaluative dimensions for anatomical patterns of wood's radial section. For the softwood's radial section, from Figure 4-1: The sensorial dimension, we can see that Khingan fir, Stiffleaf juniper, Korean pine, Dahurian larch and Mongolian scotch pine all locate in the "smooth & soft" quadrant. The pits of Stiffleaf juniper and Korean pine shape like oval, thus creating s feeling of soft; Korean pine is more than that, it looks more smooth. However, Japanese yew locates in the "smooth & hard" quadrant due to its lenticular pit aperture, spiral thickening and slant arrangement, which makes the patterns look a bit hard.

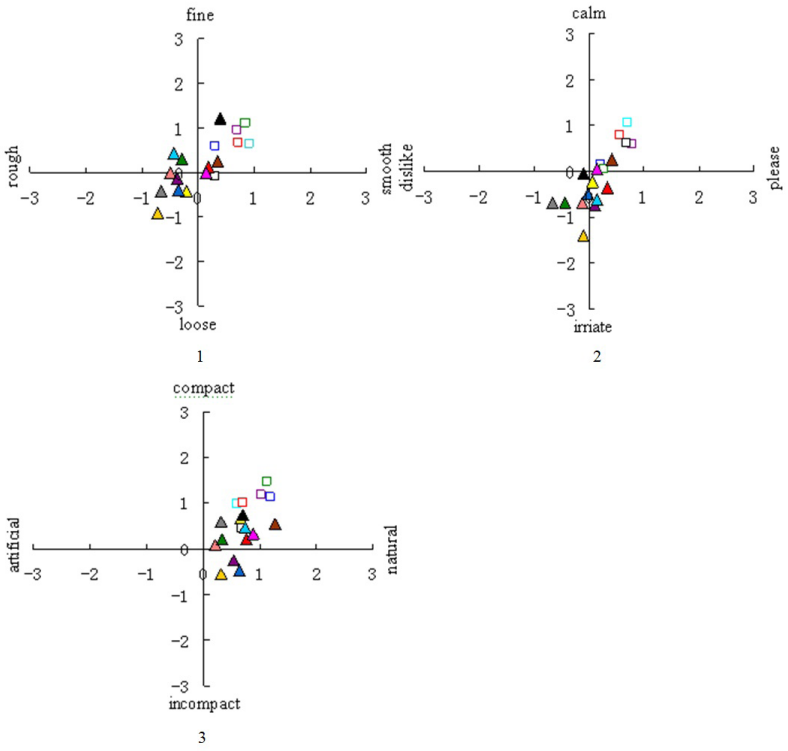

Fig. 3: Wood transverse section anatomical patterns of sensory, emotional, evaluation dimensions of quadrant distribution state. 3--1: Sensory dimension quadrant distribution. 3--2: Emotional dimension quadrant distribution.3--3: Evaluation dimensions quadrant distribution. (Square represents softwood: KP DL MP KF SJ JY. Triangle represents hardwood: WB UP DB MA MO SE MW CW CH MM AM BL)

From Fig. 4-2: The emotional dimension, we observe that Khingan fir, Stiffleaf juniper, Korean pine, Dahurian larch, Mongolian scotch pine, and Japanese yew all locate in the "mellow & please" quadrant, among which Korean pine is the softest, so it gives subjects a feeling of "quite like it".

From Fig. 4-3: The evaluative dimension, we know that Khingan fir, Stiffleaf juniper, Korean pine, Dahurian larch and Mongolian scotch pine locate in the "exquisite & concise" quadrant. The paired pits of Korean pine and Khingan fir are rather big and rank regularly, thus creating a sense of "concise"; Dahurian larch's tracheids arrange neatly, making a sense of "exquisite"; Japanese yew locates in the "exquisite & complex" quadrant, for the cells in its radial section pile in complex order, giving a complex feeling.

For the hardwood's radial section, from Fig. 4-1: The sensorial dimension, we can see that most hardwood locate in the "rough & hard" quadrant. The cells of Manchurian ash present criss-cross and disorganized order, thus creating a feeling of rough. However, Amur maackia locates in the "smooth & soft" quadrant due to the vertical and horizontal order of the cells, which make the patterns look a bit smooth and soft.

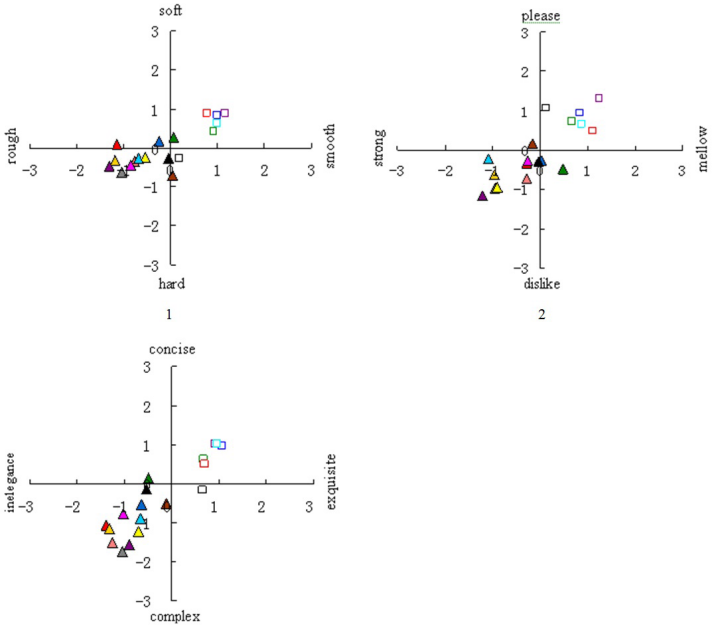

Fig. 4: Wood radial section anatomical patterns of sensory, emotional, evaluation dimensions of quadrant distribution state. 4--1: Sensory dimension quadrant distribution. 4--2: Emotional dimension quadrant distribution. 4--3: Evaluation dimensions quadrant distribution. (Square represents softwood: KP DL MP KF SJ JY. Triangle represents hardwood: WB UP DB MA MO SE MW CW CH MM AM BL)

From Fig. 4-2: The emotional dimension, we observe that most hardwood locate in the "strong & dislike" quadrant, because of the disordered cell arrangement for the radical section and strong change formed the patterns, which made the subjects felt a sort of uncomfortable. While the cells of Amur maackia pile up in good order, so it tends to be soft.

From Fig. 4-3: The evaluative dimension, we know that most of the hardwood locate in the "inelegance & complex" quadrant. The cells of Ussuri poplar and Mongolian oak formed the extremely irregular order of the patterns, which giving a complex feeling. By contrast, Amur maackia is more concise.

Evaluation and analysis of sensory, emotional, evaluative dimensions for anatomical patterns of tangential section in wood

Fig. 5 is the quadrant distribution state of sensorial, emotional, evaluative dimensions for micro-structure patterns of wood's tangential section. For the softwood's tangential section, from Fig. 5-1: The sensorial dimension, we can see that Khingan fir, Stiffleaf juniper, Korean pine, Dahurian larch, Mongolian scotch pine and Japanese yew all locate in the "flat & straight" quadrant, among which the patterns of Dahurian larch look more straight, and Khingan fir more flat.

From Fig. 5-2: The emotional dimension, we observe that Khingan fir, Stiffleaf juniper, Korean pine, Dahurian larch and Mongolian scotch pine all locate in the "beauty & free" quadrant. Korean pine's tracheid, wood ray and resin duct arrange a bit irregularly, creating a

sense of "free"; while Khingan fir's arrange neatly, looking graceful; Japanese yew's tracheid molecules are long and tilted, thus producing a feeling of "sedulously graceful".

From Fig. 5-3: The evaluative dimension, we know that Khingan fir, Stiffleaf juniper, Korean pine, Dahurian larch and Mongolian scotch pine all locate in the "regular & decorative" quadrant. The cell-piled structure patterns of Khingan fir look more regular, so it is often used for decorative purpose; Japanese yew is rather modest in application and decoration.

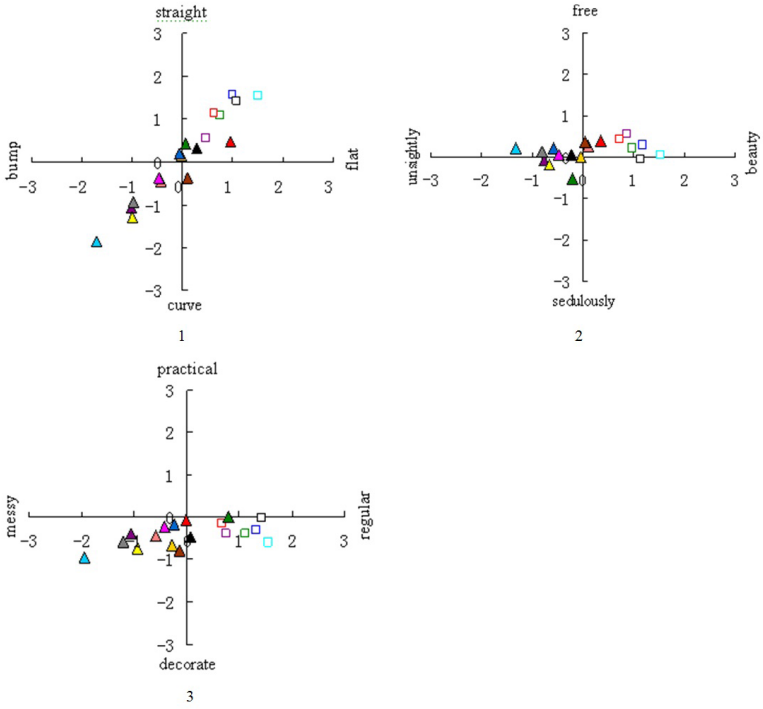

Fig. 5: Wood tangential section anatomical patterns of sensory, emotional, evaluation dimensions of quadrant distribution state.5--1: Sensory dimension quadrant distribution. 5--2: Emotional dimension quadrant distribution. 5--3: Evaluation dimensions quadrant distribution. (Square represent softwood: KP DL MP KF SJ JY. Triangle represent hardwood: WB UP DB MA MO SE MW CW CH MM AM BL)

For the hardwood's tangential section, from Fig. 5-1: The sensorial dimension, we can see that most hardwood locate in the "bump & curve" quadrant, among which the patterns of Black locust look more bump and curving due to its cell piled structure was very disordered and changed intensively.

From Fig. 5-2: The emotional dimension, we observe that most hardwood locate in the "unsightly & free" quadrant, among which the disordered anatomical structure of Black locust made the subjects felt ungraceful. However, the wood fiber of Amur maackia presents storied order, producing a feeling of deliberate; while the anatomical structure of Asian white birch takes on longitudinal arrangement, thus it looks graceful.

From Fig. 5-3: The evaluative dimension, we know that most hardwood distribute in the "messy& decorative" quadrant. Although the cell-piled structure patterns look messy, it is

often used for decorative purpose. The cells of Amur maackia piled up well arranged and a bit organized, so it is modest in application and decoration, while the psychological feeling and evaluation of the subjects were more various for the disordered patterns of Black locust, but after evaluation, its decorative function is more apparent.

Evaluation of differences of sensory, emotional expression for anatomical patterns of softwood and hardwood

Fig. 3 also represents the quadrant distribution state of sensorial, emotional, evaluative dimensions for anatomical patterns of 18 species of trees' transverse section. From Fig. 3-1: The sensorial dimension, for the transverse section, softwood is fine and smooth but hardwood is rather rough and loose for its cellular molecules are complex than that of softwood. From Fig. 3-2: The emotional dimension, softwood's transverse section makes people feel calm and pleased, while hardwood is not as good and sometimes even irritates people and in semantic differential rating scale, it is in indifferent scale. From Fig. 3-3: The evaluative dimension, softwood and most of the hardwood produce a compact and natural feeling. So, many of the softwood transverse section cell patterns can produce good emotion psychological reaction at low magnification (50x to 100x), and superior to low magnification (50x) view of hardwood transverse cell patterns.

Fig. 4 also represents the quadrant distribution state of sensorial, emotional, evaluative dimensions for anatomical patterns of 18 species of trees' radial section. From Fig. 4-1: The sensorial dimension, for the radial section, softwood is smooth and soft while hardwood is slightly rough and hard. From Fig. 4-2: The emotional dimension, softwood's radial section is soft and pleasing, but hardwood gives people a strong feeling and makes them feel uncomfortable. From Fig. 4-3: The evaluative dimension, most softwood leaves a concise and exquisite impression, but hardwood gives a complex and inelegance impression. Because of softwood radial section cell patterns are all high magnification (200x to 450x), and hardwood are low magnification (75x to 100x), so it can be seen from the figure that many of the softwood cell patterns are much more emotional psychological feeling at high magnification than hardwood at lower magnification.

Fig. 5 also represents the quadrant distribution state of sensorial, emotional, evaluative dimensions for anatomical patterns of 18 species of trees' tangential section. From Fig. 5-1: The sensorial dimension, for the tangential section, softwood is rather flat and straight whereas hardwood is bump and curving. From Fig. 5-2: The emotional dimension, the tangential section of softwood and hardwood both impress people with its free beauty; softwood is thought to be beautiful but most of the hardwood is not. From Fig. 5-3: The evaluative dimension, for the tangential section, though softwood's patterns are slightly regular, and hardwood's are a bit messy; both all trees can be used for decoration according to the different evaluation. So, all of the softwood tangential section cell patterns are good emotion psychological reaction at low magnification (100x), and they are superior to low magnification (50x to 100x) view of hardwood transverse cell patterns.

CONCLUSIONS

In the sensorial dimension, for the transverse section, softwood is fine and smooth but most of the hardwood is rather rough and loose; for the radial section, most of the softwood is smooth and soft, however, hardwood is slightly rough and hard; for the tangential section, softwood is rather flat and straight, most of the hardwood is bump and curving.

In the emotional dimension, softwood's transverse section makes people feel calm and pleased, while most of the hardwood's transverse section is not good enough, but sometimes

irritates people. Softwood's radial section is mellow and pleasing, but hardwood gives people a strong feeling and makes them feel uncomfortable. What's more, the tangential section of softwood and hardwood both impress people with its free beauty. Softwood is thought to be beautiful but most of the hardwood is not.

In the evaluative dimension, for the transverse section, softwood and most of the hardwood produce a tight and natural feeling; for the radial section, most softwood leaves a concise and exquisite impression, but hardwood gives a complex and inelegance impression; for the tangential section, although softwood's patterns are slightly regular, and hardwood's are a bit messy, both of them can be used for decoration.

A low magnification view of transverse and tangential section of softwood can produce the good emotion psychological reaction, and they are superior to the low magnification of hardwood. A high magnification view of radial section cell patterns of softwood in emotional psychology feelings looks better than that of hardwood.

ACKNOWLEDGMENT

The study was funded by the National Natural Science Foundation of China (Grant No. 30871967).

REFERENCES

1. Dalton, P., Maute, C., Oshida, A., Hikichi, S., Izumi, Y., 2008: The use of semantic differential scaling to define the multi-dimensional representation of odors. NIHPA, Journal of sensory studies 23(4): 485–497.
2. Hsu, S.H., Chuang, M.C., Chang, C.C., 2000: A semantic differential study of designers' and users' product form perception. International Journal of Industrial Ergonomics 25(4): 375-391.
3. Liu, Y.X., 1994: Wood visual environment. Harbin: Northeast Forestry University Press. Pp 160-185. (In Chinese).
4. Liu, Y.X., Li, J., Wang, M.D., 1995: Analysis on the characteristics of visual environmental science of wood surface. The relation between visual physical magnitude and visual psychological magnitude of wood surface. Wood Industry 9(2): 4-17.
5. Liu, Y.X., Yu, H.P., Zhang, X.Q., 2003: The system of wooden environment evaluation. Journal of Huazhong Agricultural 22(5): 499-504.
6. Masuda, M., 1992: Visual characteristics of wood and the psychological image. Mokuzai Gakkaishi (Journal of Japan Wood Research Society) 38(12): 1075-1081.
7. Nakamura, G., Takachio, H., 1960: Reflection of light and roughness on sanded surface of wood. Mokuzai Gakkaishi (Journal of Japan Wood Research Society) 6(6): 237-242.
8. Nakamura, M., Masuda, M., 1995: Visual characteristics of shading in edge-grain patterns. Mokuzai Gakkaishi (Journal of Japan Wood Research Society) 41(3): 301-308.
9. Nakamura, M., Masuda, M., Imamichi, K., 1996: Description of visual characteristics of wood influencing some psychological images. Mokuzai Gakkaishi (Journal of Japan Wood Research Society) 42(12): 1177-1187. (in Japanese).
10. Yamada, T., 1987: Wood Environmental Science. Kaiseisha Press.

11. Yu, H.P., Liu, Y.X., Liu, Z.H.B., Zhang, X.Q., 2004: Prediction of wood's environmental quality by amendatory visual physical parameters. Journal of Northeast Forestry University 32(6): 39-41.
12. Zhao, G.J., 1997: Fluctuation spectrum of sood structure and creature physical rhythm. Wood Industry 11(6): 22-25.

Sha Sha Song, Guangjie Zhao
Beijing Forestry University
College of Materials Science and Technology
Qinghua Eastroad 35
Haidian
Beijing
China 100083
Corresponding author: zhaows@bjfu.edu.cn
Phone: 86 010 62337751