Affective Fusion of PAD Model-Based Tactile Sense: A Case Study of Teacups

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Abstract. This study explores on emotion and perception of teacups in subject teams of sighted people and blind people through the tactile sense. Two subject teams are arranged individually to touch the teacups one by one separated by curtains in a room. After observing and investigating, PAD emotion scale will be applied to evaluate emotion of participants. The researcher explores whether haptic sense effect is produced from participants' tactual behavior with one set teacup. The finding is shown that: (1). The emotional effects of the blind subjects are more extreme than the sighted subjects in pleasure and arousal dimensions; (2). A teacup with oblique relief texture can make the unsighted subjects more pleasure emotions; (3). A straight line makes the blind subjects more uncertainty feelings and result in a negative emotional state; (4). Compare to the unsighted subjects, there is only a little difference between positive and negative emotion in the pleasure state of sighted subjects.

Keywords: Haptic, PAD scale, Emotion.

1 Introduction

Human being received most of 80% information and messages through sight [5]. That is the reason why researchers have taken much more time and energy devoting to the study of picture perception in vision than in touch [15]. However, affective expression of people is naturally communicated by multiple body sense organs [6]. Differently, the blind must contact everything from tactile and hearing sense. Recently, some researchers have represented that distinct emotions such as anger, fear, happiness, sympathy, love, and gratitude can be formed by touching communicating [9]. Moreover, the emotions communicated by haptic is commensurate to facial and vocal displays of emotion [10]. It is known that the blind will be more sensitive than sighted people caused by their impaired vision that resulting in penetrative tactile of hands. That is, to survey the tactile actions of blind people seems to infer their state of emotion and perception.

In this paper, we engaged in participant-observation to observe and record behaviors of subjects on touching with the teacups. Then we measure emotion and perception of the tactile sense by using PAD model, validate PAD theory's correctness and applicability in haptic area and verify its feasibility.

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The experiment is designed to collect mainly PAD data following the guidance of original M-R (Mehrabia-Russell, 1974) model [16], traditional Chinese version [11]. Then, we also divide tactile emotion into eight spaces (+/-pleasure, +/-arousal, +/-dominance) based on Mehrabia's model [8] and built a PAD data set.

The object of this paper is trying (1) to explore the emotional difference between the unsighted and sighted people through touch "Persona Teacup"; (2) to compare the difference of affective fusion between the unsighted and sighted people with PAD scale. The paper is organized as follows. Section 2 reviews the related literatures on haptic sense, the blind, and PAD model. Section 3 describes the case study of tactile experiment. Section 4 presents experimental results, and Section 5 concludes the paper.

2 Literature Survey

This section first reviews related literatures of haptic sense of the blind, then, introduces the features of PAD model that may be applied to questionnaire design, then; the tools of PAD scale are applied to evaluate the tactile experiment of two subject teams. Finally, statistical analysis will do with the experimental data and be discussed.

2.1 Haptic Sense of the Blind

Previous many approaches have been explored to discuss the tactile sense of the blind, for instance, whether subjects touch graph in single hand then draw down graph or express the name of the graph after touching, acquired unsighted people is better than innate unsighted people[1]. Moreover, graphic experience of innate unsighted people shaped from haptic experience. When congenital unsighted people want to form specific graph experience, they must realize absolutely the size and range to the object, while the object which is touched should be similar to real entity [7].

An important research of human factor named "two-point threshold" show that the near fingers' tip is, the smaller the value of two-point threshold is, it means that the sensitivities of fingertips are more intense than other parts of hands [20]. For correct relationship of tactile exploring strategy and shape matching, another early study from [12] concluded five exploring strategy including： (1) thoroughness; (2) tracing; (3) feature comparison; (4) congruent perimeter comparison; (5) mirror-image perimeter tracing. Another study pointed out three limitations of the tactile cognition and recognition of the blind: (1) experience and style; (2) haptic modes; (3) influence of the environment each other [2].

In an experiment on observation named sensitive about index fingers, the visually impaired subjects and sighted subjects but are blindfolded can be noticed that all of them touch the surface on an object by the tip of fingers [15]. The visually impaired subjects usually catch enough information more effectively to construct a mind map by a pair of hands. Nevertheless, sighted subjects used to touch icon or relief by one hand or a finger resulted from aid of memory in mind, even if they are blindfolded [18].

2.2 PAD Model

PAD emotional model was established by Albert Mehrabian and James A. Russell in 1974, and then some studies took it to be a measurable tool for peoples' emotion. The PAD emotional model was regarded as more effective in evaluating emotional responses of subjects than others [8].

To conduct the PAD model approach, some researchers can measure emotional tendencies and affective states along three dimensions: pleasure vs. displeasure, arousal vs. non-arousal and dominance vs. submissiveness. According to three dimensions of PAD scale, Lang [13] developed "SAM" (Self-Assessment Manikin) scale uses emotional keywords of PAD are replaced by five icons within SAM. The evaluation method is that after subjects watch every stimulant material, then, to choose an icon which is matched subjects' emotion. Based on SAM, Desmet [4] built another dynamic icon system to supersede still icons named "PrEmo" scale. In "PrEmo" scale, seven negative mood icons at the left, while seven positive mood icons at right and stimulant on the corner of left.

Li [14] announced the simple Chinese version of PAD (SCP) emotional scale, which is composed of adjectives of 12 couples, decreased from 18. However, Hsieh [11] argued that there was no satisfactory on reliability and validity when PAD scale was transferred to SCP. The SCP with well reliability and validity in "pleasure" and suitable reliability and validity in "arousal", whereas without enough value in "Dominance".

3 Research Design

This section represents the methods that adopted in this case study. The sixteen subjects touch the teacups individually one by one in order. The experimental data are collected and analyzed by an applied statistics.

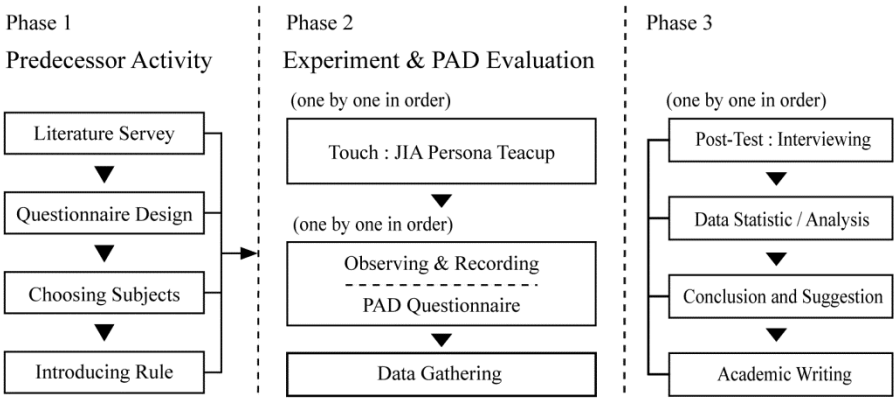

Fig. 1. Research Flowchart

3.1 Research Flowchart

The main goal of this study is to explore the emotion and cognition of tactile sense generated through the blind and non-blind participants' touching with two sets of teacups. We do with the PAD questionnaire interviews of participants. They are asked individually to describe and explain how they feel as detailed as possible. Finally, researchers integrate data to run statistical program and analyze the result to summarize the study. The research flowchart is shown by Figure 1.

3.2 Stimuli and Design

Four teacups of one set named "Persona Teacups" (in Chinese:异同杯) are selected from brand JIA to be our stimuli materials. Although "Persona Teacups" whole set is all made by porcelains and same compendium in shape, they are quite out of divergence in decorative design with different low relief textures on their bodies. Therefore, we call the teacups basing on their textures to be: A-Circle Dot; B-Straight Line; C-Square Dot; D- Oblique Line. To handle experiment smoothly and avoid the visual interference, we separate four teacups to put in independent boxes and cover top only retain front transparent for taking pictures. The "Persona Teacups" and their relief textures are shown by Figure 2.

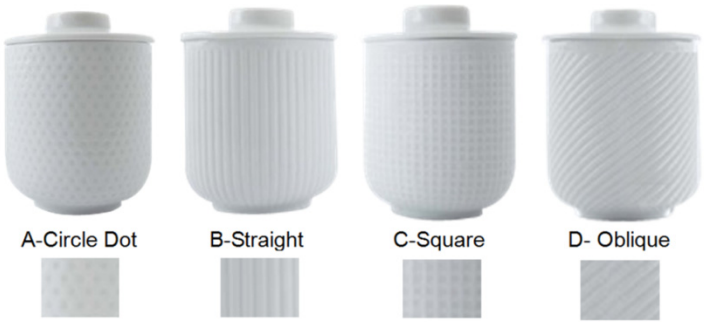

Fig. 2. "Persona Teacups" and Their Relief Textures

3.3 Subject Teams

Sixteen subjects (eight blind people) volunteered to take part in the experiment. Age ranged from 20 to 24 years. All subjects we choose from one organization at random. Due to experimental necessity, the unsighted subjects can be selected only congenital blind people not acquired blind people. All subjects are asked to confirm that they have no experience in touching "Persona Teacup". All of subjects: (1) age without big difference; (2) boy and girl are same; (3) half sighted people and half blind people. The information of two subject teams is listed by Table 1.

Table 1. The Information List of Subject Teams

No.	Blind(B) / Sighted (S)	Age	Gender	Code Name
1	B	21	Male	01BM21
2	B	22	Female	02BF20
3	B	20	Male	03BM19
4	B	20	Female	04BF20
5	B	22	Male	05BM22
6	B	21	Female	06BF21
7	B	23	Male	07BM20
8	B	24	Female	08BF20
9	S	20	Male	09SM20
10	S	22	Female	10SF22
11	S	21	Male	11SM21
12	S	20	Female	12SF22
13	S	24	Male	13SM23
14	S	21	Female	14SF24
15	S	21	Male	15SM21
16	S	22	Female	16SF22
Total	B:8 / S:8	F:21.5 (mean) M:21.5(mean)	F:8 M:8	16

3.4 Evaluative Tool

Due to language translation and difference of meaning, we take traditional Chinese version of PAD scale and refer to English version as evaluative tool. The 18 pairs of keywords are shown by Table 2.

3.5 Experimental Procedure

Before beginning of experiment, the researcher told the subjects the aim, answering rules of the study and explained that there were no absolute correct answers, no limited time, just relied on their own emotion state. The experiment was conducted in a room individually; one subject felt free to put his (her) one or two hands into a test box to touch a teacup and next step finish the questionnaire at once. This procedure was repeated until four tests had been finished. We use a Likert scale with the typical 5-level item to ask the subjects writing down (sighted subjects) or answering (the blind subjects) the PAD scale questionnaire. Although many psychometricians support to use seven or nine levels, however, a recent study argued that there was very little difference between the scale formats like 5-, 7- or 9- point in terms of variation about the mean, skewness or kurtosis [3].

Table 2. The 18 Pairs of Keywords in PAD Scale

Dimension	"+"Positive Mood	"—" Negative Mood
P(Pleasure)	Happy (快樂)	Unhappy (不快樂)
	Pleased (愉悅)	Annoyed (惱怒)
	Satisfied (滿意)	Unsatisfied (不滿意的)
	Contented(滿足)	Melancholic (沮喪)
	Hopeful (希望)	Despairing (絕望)
	Surprised (驚奇)	Bored (無聊)
A(Arousal)	Stimulated (刺激)	Relaxed (放鬆)
	Excited (興奮)	Calm (平靜)
	Frenzied (瘋狂)	Sluggish (懶散)
	Jittery(緊張)	Dull(枯燥)
	Awake (清醒)	Sleepy (睏倦)
	Aroused (喚起)	Unaroused (未被喚起)
D(Dominance)	Controlling (控制)	Controlled (被控制)
	Influential (有影響力)	Influenced (被影響)
	Uncrowned(不擁擠)	Crowded (擁擠)
	Important(重要)	Awed (不重要)
	Dominant (支配)	Submissive (服從)
	Free (自由)	Restricted (被限制)

F.3-1 A teacup in Test Box F.3-2 Test (Sighted Subject) F.3-3 Test (Blind Subject)

Fig. 3. Three Pictures of the Experiment

After whole haptic experiment was finished, researchers interviewed every subject independently at one time. Finally, all data will be evaluated and integrated. The experimental procedure was shown by Figure 3. In F.3-1, we set black cloth and a teacup on it within a test box. The sighted subjects used one hand to touch texture of a teacup (F.3-2), however, all of blind subjects adopt two palms to feel the texture of a teacup (F.3-3).

4 Results

4.1 Data Gathering

The scores on the questionnaire by five-level Likert's item, can be: 2-strongly agree/1-agree/0-neither agree nor disagree/-1-disAgree/-2-strongly disagree. The emotional attribution can be identify as "+": it means positive emotional mood of subjects; "-": it means negative emotional mood. All scores are shown by Table 3.

Table 3. The Summated Rating of PAD Data from Subjects

		A		B		C		D	
		B	S	B	S	B	S	B	S
P	Happy ─ Unhappy	+10/-0	+1/-5	+0/-2	+3/-0	+0/-4	+0/-8	+7/-0	+6/-4
	Pleased ─ Annoyed	+10/-0	+2/-1	+4/-1	+4/-0	+0/-4	+2/-1	+8/-0	+4/-4
	Satisfied ─ Unsatisfied	+5/-0	+2/-2	+0/-6	+0/-6	+12/-0	+1/-0	+3/-2	+3/-2
	Contented ─ Melancholic	+3/-0	+2/-4	+0/-5	+0/-6	+6/-0	+2/-0	+4/-1	+0/-4
	Hopeful ─ Despairing	+6/-0	+2/-0	+0/-4	+3/-1	+2/-0	+6/-0	+3/-4	+2/-4
	Surprised ─ Bored	+10/-0	+6/-1	+0/-4	+0/-6	+12/-0	+11/-0	+10/-0	+5/-3
A	Stimulated ─ Relaxed	+4/-3	+6/-2	+0/-9	+0/-7	+6/-0	+9/-0	+4/-2	+0/-7
	Excited ─ Calm	+0/-2	+0/-1	+0/-12	+0/-2	+0/-13	+1/-7	+0/-4	+2/-5
	Frenzied ─Sluggish	+0/-13	+0/-9	+0/-2	+0/-0	+0/-13	+0/-2	+0/-2	+0/-0
	Jittery ─ Dull	+0/-6	+0/-3	+0/-3	+0/-12	+0/-7	+0/-6	+3/-3	+4/-5
	Awake ─ Sleepy	+5/-0	+11/-0	+6/-0	+0/-3	+10/-0	+8/-0	+6/-0	+0/-3
	Aroused ─ Unaroused	+8/-0	+7/-0	+0/-13	+0/-4	+7/-0	+3/-2	+3/-2	+6/-0
D	Controlling ─ Controlled	+0/-9	+0/-9	+0/-13	+0/-6	+0/-7	+0/-6	+9/-0	+5/-3
	Influential ─ Influenced	+6/-2	+3/-5	+0/-8	+0/-5	+7/-6	+2/-8	+9/-0	+7/-1
	Uncrowded ─ Crowded	+0/-10	+0/-11	+0/-13	+0/-5	+0/-12	+0/-14	+8/-0	+1/-4
	Important ─ Awed	+0/-6	+0/-0	+9/-0	+2/-2	+4/-0	+6/-1	+7/-0	+7/-0
	Dominant ─ Submissive	+0/-11	+0/-6	+0/-11	+0/-2	+0/-3	+0/-3	+0/-11	+0/2
	Free ─ Restricted	+0/-10	+0/-12	+0/-14	+0/-2	+0/-3	+0/-14	+0/-10	+0/-5

*B:Blind Subjects S:Sighted Subjects

To represent further, we amount to each PAD dimension of the questionnaire items individually and integrate to positive and negative sections of scores. The integrated scores listed are shown by Table 4.

Table 4. The Integrated Scores of Each PAD Dimension

	A 		B 		C 		D 	
	B	S	B	S	B	S	B	S
P	**+44***/-0	+15/-13	+4/**-22***	+10/-19	+32/-8	+22/-9	+35/-7	+20/-21
A	+17/-24	**+24***/-15	+6/**-48***	+0/-19	+23/-33	+21/-17	**+**16/-13	+12/-20
D	+3/-39	+6/-34	+9/**-59***	+2/-22	+11/-31	+8/-46	**+33***/-21	+20/-15

B:Blind Subjects S:Sighted Subjects " * " : highest score

In general, SD (Standard Deviation) can be illustrated how much variation or "dispersion" exists from the mean; from the above table 4, we integrate values of positive and negative emotions to calculate three-dimensional scores of PAD by arithmetic mean (AM) and standard deviation (SD) individually. The data are shown by Table 5.

Table 5. The Standard Deviation & Arithmetic Mean values of Each PAD Dimension

	P				A				D			
	B		S		B		S		B		S	
	+	−	+	−	+	−	+	−	+	−	+	−
AM	**28.8***	9.3	16.8	15.5	15.5	**29.5***	14.3	17.8	14	**37.5***	9	29.3
SD	14.96	7.98	4.66	4.77	6.10	12.82	9.34	1.92	11.36	13.96	6.71	11.82

AM：Arithmetic Mean; SD：Standard Deviation

" * " : highest score +": positive emotion; "-": negative emotion

5 Conclusion

Although this is a pilot study, and we adopt small samples in this experiment, the finding is shown as followed:

1. In this case study, "A" teacup can give rise to pleasure emotion state of the blind subjects significantly.
2. "B" teacup result in a more negative emotional state in terms of other teacups, especially in the blind subjects. The three-dimensional values of PAD tested by the blind subjects achieve to be higher level than the sighted subjects. To interview the blind subjects, they state that the texture of straight line makes them more uncertainty feelings.
3. In PAD scale, "Pleasure" means to measure how pleasant an emotion may be, in case of comparing two subject teams, complex texture especially oblique pattern

like teacups "A", "D" can bring more pleasurable feeling to the blind subjects, however, the sighted subjects prefer neat texture to more variational, oblique pattern, hence, for sighted subjects, "C" teacup is pleasurable.
4. In PAD scale, "Arousal" means to measure the intensity of the emotion, "C" teacup seems to stimulate the sighted subjects more positive response than others, and "A" and "D" teacups for the blind subjects, too.
5. In SD values, "Pleasure" SD of the sighted subjects shows an equal value nearly. However, there is an extreme gap between positive and negative emotions of the blind subjects by "Pleasure" SD and "Arousal" SD.

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