ThuPIS: A New Affective Image System for Psychological Analysis

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***Abstract*—Traditional evaluations of human psychological status usually have a great dependence on the experience of the operator, and it is still a challenge to automate the evaluation process. In this study, a new image system ThuPIS (the Tsinghua Psychological Image System) is designed based on Minnesota Multiphasic Personality Inventory (MMPI), a classical personality inventory in clinical mental health diagnose. The goal of ThuPIS is to build an ontology of affective images, which can active difference of physiological reactions among people with different psychological status. Specific image contents were chosen according to the items of MMPI, and organized by a hierarchy structure. Images were rated according to an overall impression, and those with affective ambiguous were eliminated. An experiment was conducted based on ThuPIS, and the results provide evidence that images in this image system could lead to difference in response time of positive facial expression when participants hold different attitudes towards the background images. This new image system could also supplies materials for other studies on human cognition. It is a brand new work and more practical assessments on the new image system are expected along the way.**

Keywords-psychological evaluation; image system; MMPI; response time; affective image.

I. INTRODUCTION

Traditionally, human psychological status are evaluated based on conversations between subjects and clinical psychologists, or the Self-Assessment Manikin (SAM) submitted by the patients. Conducting personality tests is a relatively convenient and accessible method to help with psychological evaluating. However, the accuracy of evaluating results of these traditional ways largely depends on the abundant experience of the dominant player of the evaluation, and the conscience and honesty of the participants, which is susceptible to subjective factors. It is of great significance to convert the process of psychological status analysis to a serial of behavioral trials, from which the numeral psychological features are obtained, and complete evaluation automatically with computers, in order to make the psychological evaluation more objective and convenient. This spurs the idea to build a new image system with psychological meanings to help access this goal.

Behavioral and neuroscience studies have revealed a substantial interaction between emotion cognition and psychological status. People with different psychological status may react to emotional stimulus very differently, for example, people with anxiety disorder paid an accessional attention to emotional facial expressions according to studies by Bradley [1, 2]. Serving as visual stimulus, emotional images play well in arousing participants' emotions, and have been introduced to a variety of psychological experiments. Besides, reading of images is usually an easy work, which can be accepted by the majority. Thus images may be perfect materials that can help inspire differences in behaviors, such as response times, among people with diverse psychological status. Then the problem becomes how to choose proper images that can meet all the requirements of psychological evaluation.

For now, the most famous image system for psychological application is the International Affective Picture System (IAPS), which provides a large-scale ontology of emotionally evocative color photographs [3]. Additionally, each picture in this system has been rated by three affective dimensions, which are pleasure, arousal and dominance [4]. A more recent affective picture database is GAPED [5], which gathered affective pictures with specific contents. However, IAPS and GAPED are designed simply for research on emotion, and their lack of psychological meanings limits their application to a more extensive use, also the evaluation of psychological status. As a result, a new image system is recommended to help with psychological evaluation.

To promise the effectiveness of the new image system, it is of great importance to decide what kind of images should be selected and how the structure should be organized. Minnesota Multiphasic Personality Inventory (MMPI), which is one of the most famous personality tests in mental health [6], was chosen as reference according to which to choose images. The MMPI is consisted of items expressing objects or activities that relate to one or more psychological status, which can be tested by the 10 clinical scales of MMPI. Although assessments made with MMPI not always give correct results, items in MMPI cover a majority of visions which are considered more important to reflect one's psychological status. These visions are borrowed from MMPI, and serve as the primary context meanings of images in ThuPIS. This contributes to the new image system stands out as affective stimuli when compared with other image systems. In actual work, the Chinese version of MMPI [7] is used, as the first potential objects are Chinese. That introducing

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personality inventory to the construction of image system is a totally new work, and paves the way for promoting the research of image cognition from the coarsely emotional impact to a real sense of the comprehension of image contents.

Our work aims at building a new image system, providing a serial of images cited with particular psychological meanings associated with MMPI, paired with a tag of positive, negative or neutral to express affective attributes. This new image system is built to support the new psychological evaluation to help monitor human mental health. Besides, it can also be applied to other kind of studies relying on image cognition. The following parts of this paper are organized as follows. Section 2 throws light upon the process of mapping MMPI to the image system in detail. Section 3 illustrates an experiment applying the new image system. Finally, a summary is drawn in section 4.

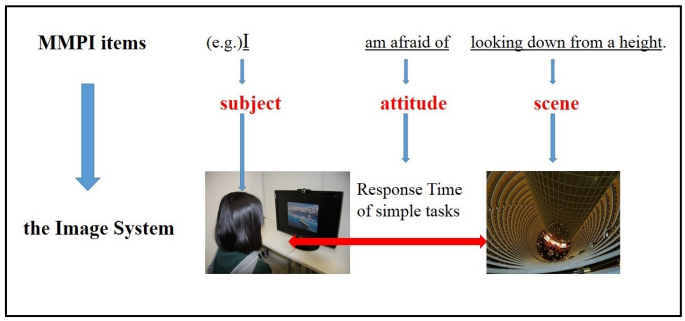

Figure 1. Conversion from MMPI to the image system.

II. METHOD

A. Conversion from MMPI to the image system

Building the new image system is essentially to convert a personality inventory, the MMPI, pure described by written words, to the contents of images. An analysis of the Chinese version of MMPI shows that, 326 items of the totally included 567 items can be destructed into a subject-verb-object structure, and the left items are also related to certain behaviors or activities in daily life. For example, questions like "I like reading crime news in the newspaper", "I am afraid of looking down from a height", and so on, are all describing things that the subject, which always be "I", like or dislike. By answering with a "Yes" or "No" can represent the subject's attitude towards the objects referred in these MMPI items. This kind of sentence structure of MMPI items provides a possible transformation which converts the form of answering MMPI questions to viewing images. In Figure 1, this conversion process is visualized. By catching the response time to simple tasks, or other kind of physiological characteristics when subjects viewing images, the subjects' attitude towards the image contents can be indirectly obtained, which implies the answers to the prototypal MMPI questions. Taking this way, the words related MMPI items are converted to vivid scenes expressed in images, which contribute to the final image system.

B. Hierarchical structure of the image system

For ease of use, this image system is well classified, and follows a hierarchical structure derived from MMPI, according to which images are chosen in the new system.

Early studies have revealed that all the MMPI items can be clearly classified into 25 categories [8], and according to the analysis in the present study, this classification can also be applied to the Chinese version of MMPI, but with some items reassigned from one category to another. Then these 25 categories are token as the primary categories of the new image system, which are listed in the second column of Table 1. The first column of Table 1 lists the top layer of the hierarchical structure, which is generated by merging categories with similar topics together. Similarly, the MMPI items related to similar objects, behaviors or activities are patched together, and the topics related consist the third layer of the hierarchical structure.

It is notable that the each node in the last layer of the hierarchical structure is corresponding to a patch of MMPI items with the same or very similar objects, but not only one item, because the image contents cannot always match the item so precisely. Figure 2 shows a branch of this hierarchical structure as example.

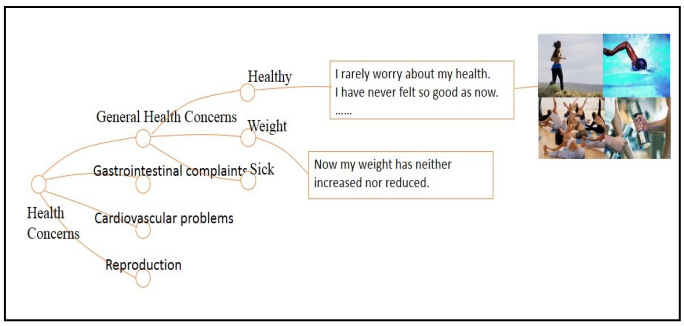

Figure 2. An example branch of the image system

C. Affective rating

In order to guarantee that images won't be affective ambiguous, a website platform is built to collect affective ratings. Following IAPS [3], a 9-point scale Self-Assessment Manikin was introduced here. Participants were asked to rate images according to their overall impression, and point 1 represents extremely negative emotion, while 9 represents extremely positive. The ratings stand for the participants' attitude towards the images.

When the ratings of an image fluctuate too wildly, then this image will be considered affective ambiguous and kicked out of the image system. In practice, this filtration is accomplished by a much easier judgment. The 9-point scale is uniformly divided into three levels, standing for negative, neutral and positive respectively, and the percentages of votes in each level are computed. If the highest percentage is less than 70% when the total votes have reached 30, the image will be kicked out. Otherwise, the image will be retained, and its confidence of classification will be represented by its distribution of ratings.

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D. The present work

The new image system ThuPIS aims at providing a serial of affective color images based on the contents from MMPI items. It follows a hierarchical structure generated by analyzing the contents of MMPI, and has eight basic categorizes as listed in Table 1. Each branch in this hierarchical structure has a depth of four to five. For now, there are totally 199 nodes at the last layer of the hierarchical structure, and each with 3 to 20 images. A total number of 823 images are waiting online to be rated. Most of the images are photographs of daily life, while paintings, cartoons, and computer drawn abstract pictures are also included in order to match the MMPI items better. Besides, each image in this image system is cited with positive, negative or neutral to mark its affective attribute which is accepted by the majority. This additional information should be helpful when experiment results based on the image system being analyzed.

TABLE I. THE TOP TWO LAYERS OF THE HIERARCHICAL STRUCTURE

First layer	Primary categorizes
Health concerns	General health concerns, Gastrointestinal complaints, Cardiovascular problems, Reproduction
Organic Symptoms	General neurological symptoms, cranial nerve related, pathology, sensitivity, Vasomotion and endocrine
Mental Health	Depression, Mania, Obsessiveness, Bizarre mentations, Fears, Sadomasochistic tendencies
Family Problems	Family Problems
Social Adjustment	Social adjustment, occupational attitude
Worldview	Religious fundamentalism, Political attitude
Self-concept	Morale, Habits, Feminine interests, Education
Sexual attitude	Sexual attitude

III. EXPERIMENT

An experiment based on ThuPIS was carried out to provide initial evaluation of this new image system. The purpose was to proof that response time of simple tasks will be interfered by the background images. Previous studies has pointed out that the responses for positive facial expressions are significantly faster when the faces are displayed on positive backgrounds than on negative ones [9, 10]. However, these studies were all based on the IAPS. In this experiment, images from the current image system would serve as backgrounds, and emotional facial expressions would be presented as targets. Participants were forced to view background before the target facial expressions' appearance, in order to promise that the information of images has been passed on to the participants. Followed the work in [10], the task was still to categorize the target facial expressions, and the response times were recorded.

A. Participants

Twenty-nine university students (9 females and 20 males, mean age = 22.7, SD = 4.73) participated in the experiment. Only participants reported no history of neurological problems were accepted. All participants were right-handed, and had normal or corrected-to-normal vision. Informed consent was obtained from each participant. Participants were paid 30 RMB as reward for their participation.

B. Materials and Procedure

Thirty clearly positive images and thirty clearly negative images selected from ThuPIS, the new image system, were displayed as backgrounds. Four positive and four negative eigenfaces, generated in the same way as [9], were taken as target facial expressions. Then a serial of eighty face-scene combinations were selected, and they would turned up following a random order for each participant. The procedure is shown in Figure 3. When a trial began, the background image was first displayed for a random period ranging from 500 to 1000ms, then the target facial expression appeared on the center of the screen. The task was to categorize facial expressions into positive and negative as fast as possible. Half of the participants were asked to press 'F' for positive facial expressions, and 'J' for negative facial expressions. Another half were inverse. There was a blank period of 2000ms between each trial. Each participant needed to complete all the 80 trails, with an additional warm-up of 8 trials, and only trials with positive facial expressions were considered valid. All scenes were displayed on a black background with a size of 21.5cm×28.7cm (20.3°×26.9°), while facial expressions were displayed at a size of 5.3cm×4.2cm (5.1°×4.0°). Participants sat at a distance of 60cm from the screen. Response times for positive facial expressions were recorded.

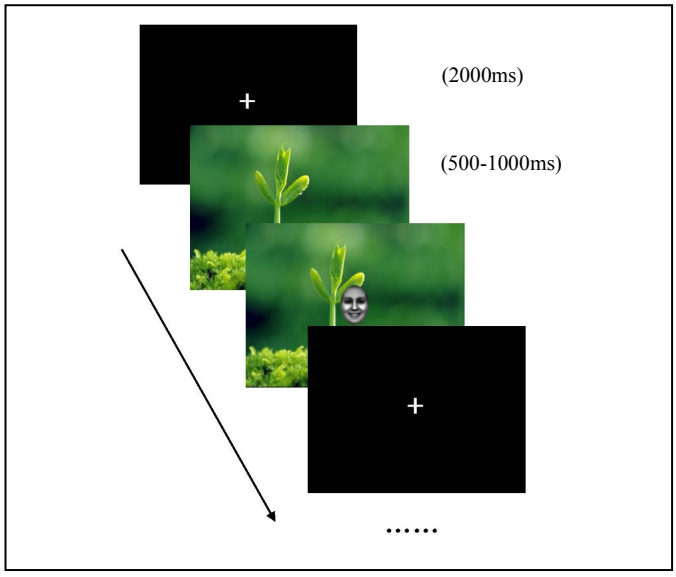

Figure 3. The procedure of experiment

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C. Results and discussion

The analysis of the response times showed a significant main effect for background scenes paired with positive facial expressions. Responses for positive facial expressions in positive scenes (mean=626ms, SD=16.2) were significantly faster than that in negative scenes (mean=645ms, SD=15.0) [$t(28) = 3.00$, $p < .01$, $d = .56$]. The results were just as expected. Response time to simple tasks of facial expression recognition was interfered by the prior cognition of background scenes. When the participants hold a positive attitude to the scene, the responses for positive facial expressions were faster. This result suggests that when the task is to categorize facial expressions, the response time for positive facial expressions implies the participants' attitude toward the background scene. This experiment supports that the image system can help evaluating human psychological status, and gives an example applying the image system.

IV. Conclusion

The present study focuses on building a new affective image system, the ThuPIS. Contrary to any other existing image system, ThuPIS is designed to support automatically human psychological status evaluation. This very specific purpose determines that psychological meanings are essential to the image system, and then Minnesota Multiphasic Personality Inventory, the classical personality inventory is chosen as the base of ThuPIS. Images in this new system are organized following a hierarchical structure derived from the contents of MMPI items, which highlights the specific function of ThuPIS. This characteristic makes ThuPIS different with any other image systems, including the IAPS. In addition to the goal of psychological evaluation, ThuPIS simultaneously provides a benchmark for studies on cognition of visual scene stimuli. However, it is a brand new work to convert a personality inventory to an image system, and there is still a long way to go. Images in this system will be updated and filtered by much more experiments, and further assessments are expected in future work.

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