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Original Article

Influence of Building Materials with Directional Textures on the Visual Perceptions of Elderly with Alzheimer's Disease☆

Yao Rong Hwang*

Department of Architecture and Interior Design, National Yunlin University of Science and Technology, Yunlin, Taiwan, ROC

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SUMMARY

Background: Visual hallucinations are caused when complex texture images interfere with the visual transmission pathway of an individual. Overstimulation of the senses should be avoided, in order to prevent people with dementia from having hallucinations. This study attempted to find the change in visual perceptions of the elderly with Alzheimer's disease in relation to the textures of building materials, in order to determine what kind of texture might have the potential to cause the demented elderly to have hallucinations.

Methods: A total of 10 elderly people with mild dementia from Chai-Li senior care center participated in this experiment. Simulation of visual perception was made using a highly sensitive LCD projector that showed pictures of building materials on a screen. A clock drawing test was applied to assess the changes in the participants' visual perceptions between prior to and after the simulation.

Results: Visual perception in the demented elderly was more influenced by textures with lines of different widths or different ranges, and textures of crossed lines, than by textures with lines of the same width and range. The participants' descriptions in terms of the visual images that they saw actually did not exist while they looked at the textures.

Conclusion: Data about these building materials should be made available for the reference of caregivers and building managers, in order to prevent the demented elderly from having behavior problems due to environmental design. Lastly, further study is required to confirm if the building materials' influence on visual perceptions in the demented elderly correlates to the variables of age, sex, and severity of disease.

1. Introduction

It has been recognized that people with Alzheimer's disease face difficulties from sensory overstimulation, which may increase their level of distraction, agitation, and confusion[1,2]. Stimulation of the left temporoparietal junction may activate visual perceptions (colors, textures, shapes, movement, and rotation) and change them from elementary to complex information[3]. Hallucinations are caused by noise or complex images that contain color and texture entering the sensory transmission pathway, which interferes with the output order of the sensory transmission and causes confusion[4], so that many elders with Alzheimer's disease see and hear objects or images that do not exist[5].

Pattern and texture are components of every interior environment, and they can add a wealth of interest. Nevertheless, we do know that people with dementia can be overstimulated by too many patterns and textures in one space[6]. An investigation indicated that building materials, such as reflective materials (glass, mirror, or polished marble) and materials with complex textures, resulted in the demented elderly seeing images that did not exist and brought tremendous burden to caregivers[7].

Although complex texture has been addressed as the issue that may change the visual perceptions of people with Alzheimer's disease and cause hallucinations, little research on the impact of textures in dementia care environments has been conducted[1,8], other than that on lighting and visual contrast. The purpose of this research was to find the change in the visual perceptions of the elderly with Alzheimer's disease in relation to the textures of building materials, in order to determine what kind of texture might have the potential to induce visual hallucinations among elderly demented patients, as well as to provide data about building

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* Correspondence to: Dr. Yao Rong Hwang, 123, University Road, Section 3,Touliu, Yunlin 640, Taiwan, ROC.
E-mail address: hwangyr@yuntech.edu.tw.

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materials as a reference frame for caregivers and building managers.

2. Methods

2.1. Participants

A total of 10 male patients with mild dementia (represented as A, B, C, D, E, F, G, H, I, and J) from the Chai-Li Senior Care Center for retired soldiers in Tainan County, Taiwan participated in this experiment. Permission to participate was given by the patients' families and has been approved by the Chai-Li Senior Care Center Review Board. The Clinical Dementia Rating Scale and the Neuro-Psychiatric Inventory were applied by neuropsychiatric doctors to diagnose the patients' degree of dementia and visual hallucinations. In addition, all patients had normal vision, except for visual hallucinations. Owing to the difficulty in obtaining permission from the patients' families to perform the experiment, as well as the limited number of demented patients diagnosed as having visual hallucinations, this research had tried to search for more demented patients from other care centers in order to increase the number of participants for this experiment. However, this effort was not approved by the Chai-Li Senior Care Center Review Board.

2.2. Facility and space of visual simulation

The simulation of visual perception was made using a highly sensitive LCD projector that showed pictures of building materials on a 300-cm-wide and 280-cm-high screen. The space for the experiment was located indoors and used artificial lighting and curtains to control the illumination. In order to match the simulation on the wall to the real item as much as possible and let the participants see the whole picture and feel comfortable, the plan and evaluation of the projection and viewing distance were set as shown in Figs. 1, 2. This experiment only processed the simulation on the wall owing to the difficulty in projecting pictures on the floor.

2.3. Building material textures

It has been recognized that directional textures, periodic textures, and random textures are obviously different[9], and this research only focused texture topology on directional textures. Pattern recognition of the images was analyzed using a computer, and it was basically composed of the shape and distribution of the image elements (such as lines, blocks, and figures). The influencing factors on the shape were the width and direction of the image elements (narrow, wide, vertical, horizontal, slope, etc.). As regards the distribution of the image elements, range and density were the major dimensions for identifying the image patterns[10,11]. There are a variety of classifications for the texture patterns of surface materials in buildings that are affected by the shape and distribution of elements[12].

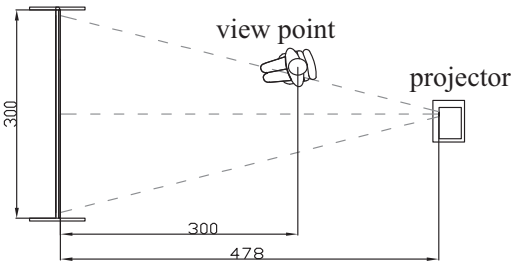

Fig. 1. Plan of picture projection and view distance.

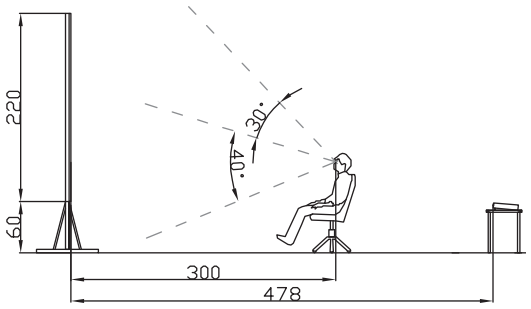

Fig. 2. Evaluation of picture projection and view distance.

According to the types of local building materials, this research collected a catalog of materials, including brick, stone, concrete, wood, tile, plastic, paint, clay, paper, and carpet, from the National Building Material Association, Taipei, Taiwan. A texture pattern analysis on the shape and distribution of the image elements, including the width, direction, range, and density of the images, was processed after the collection of the material samples. In terms of directional texture, it was classified as having lines of the same width and range, having lines of different widths or ranges, and having crossed lines (see Figs. 3–5). 3D Max (Autodesk Inc., San Rafael, CA, USA) and Photoshop 7.0 (Adobe Systems Inc., San Jose, CA, USA) software were applied to edit and scan the pictures from the catalog, in order to produce texture images that were close to the real pictures.

2.4. Clock drawing test

Clock drawing requires visual perception and visual movement to edit the positions of the numbers and the direction of the hands on a clock. As clock drawing requires several skills, including visual–spatial ability and constructional praxis, it can be used to investigate the visual space construction ability of demented elders[13,14], which is related to the degree of visual hallucination. If the demented elderly have normal visual perceptions, they will draw the correct position of the numbers and the correct direction of the hands. The clock drawing test has been applied to assess changes in the visual–spatial ability and the unreal images seen by demented patients, in order to evaluate the possibility of visual hallucinations[15,16].

In general, during the clock drawing test a piece of paper containing a circle is presented to the patient, on which he draws the numbers and the hands of a clock. The score of the test should be defined as every correct position of a number getting 1 point and the correct direction of the hands getting 1 point as well[17]. The hands should be clearly identified as being either the hour hand or the minute hand. In addition, numbers 6 and 12 must be on the vertical axis and numbers 3 and 9 must be on the horizontal axis. The positions of the other numbers will decide the rest of the scores. The total score is 10 points, including eight positions for the numbers and two directions for the hands[15] (Fig. 6). As for the direction of the hands, 11:10, 3:00, and 2:45 were applied in turn, to prevent the demented patients from becoming accustomed to the same drawing method.

2.5. Simulation procedure

Instructions and several practices of clock drawings were required to allow each participant to have a fine drawing ability prior to the formal test. During the visual perception simulation,