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ROLE OF TASK SPECIFICITY IN DEVELOPMENT OF DEPTH PERCEPTION IN CHILDREN

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Abstract

Perception of depth and distance of an object is one of the problems of discussion among psychologists from a long time. There are various psychological cues (size, interposition, linear perspective, texture and aerial perspective height and shadow) determines the depth and distance of any object which are located in space. It was found that certain depth cues are utilized by children earlier than others developmental trends were also found. Hudson has carried out fairly systematic studies of "*verbal" test* of pictorial depth perception. One major limitation of most of the previous studies of pictorial depth perception is their predominant reliance either only on "verbal measures" or only on "performance measures", which is likely to give rise to considerable errors, particularly in the case of young children. The difficulties are that subjects, who fail to interpret Hudson's pictures in a 3-D manner, provide considerable evidence for 3-D perception on other kinds of "performance" task. This term coined as "Task specificity" in performance which appears to be a recurrent feature in developmental and cross-cultural studies of cognition. The present paper is mainly emphasized Researchers have generally used only one task (either verbal or performance), which do not produce similar results with respect to pictorial depth perception. The present study tries to examine the role of task characteristics in 3-D perception skill by using a locally developed Doll placement task (DPT). It was found that children in general would appear to be 3-D perceivers more on construction than verbal task.

Introduction

Depth perception has been a problem of discussion among scientists and philosophers for decades. The basic question is how one can see a three-dimensional world with only a two dimensional or flat retina in each eye. We are able to make use of some information or cues in the sensory input to "generate" the three dimensional world that we see. Thus, depth perception is the visual ability to perceive the world in three dimensions. Depth perception allows the beholder to accurately judge the distance of objects, their spatial relationships. The 3-dimensional (3-D) world projects on to the curved surface at the back of the eye, which is two-dimensional (2-D). Since we do not have direct access to the third dimension of visual space, the visual system has to utilize various sources of information in the projection of the three-dimensional world on both eyes to recover depth, distance and the three-dimensional shape of objects.

Physiological psychologists and cognitive scientists have done considerable work on the use of physiological cues in the perception of depth (Birch, 1993). However, much of this research is focused on binocular disparity. Our perceptual system cannot rely on binocular disparity as a depth cue. However, we can still determine that some objects are nearer and others farther away. This becomes possible because of monocular cues of depth.

Monocular cues

Psychological studies of depth perception are mainly focused on the use of monocular cues. Commonly referred to as psychological cues, they are also called pictorial cues by some authors (Goldstein, 1989). *Size* serves as an important cue to depth perception. The size of the retinal image may change as an object moves closer to us or farther from us. This depth cue is known as *relative size.* When one object overlaps or partly blocks our view of another object, we judge the covered object as being farther away from us i.e Interposition cue. *Linear perspective* refers to decrease in size and separation of objects as they become more distant. The air contains microscopic particles of dust and moisture that make distant objects look hazy or blurry. This effect is called *atmospheric perspective* or *aerial perspective,* and we use it to judge distance. *A texture gradient* arises whenever we view a surface from a slant, rather than directly from above. When judging an object's distance, we consider its *height* in our visual field relative to other objects. The pattern of *light and shadow* plays an important role to judge depth in pictures.

Pictures as stimuli

In the most general sense, pictorial perception refers to an individual's response to two-dimensional representation of three dimensional objects. Thus, one way to the study of pictorial perception is through the use of pictorial depth perception tasks. Considering that the study of pictorial perception constitutes an important way of understanding depth perception (Deregowsky, 1989), psychological studies using pictorial materials have mainly

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focused on the use of monocular cues. Early research findings indicate that the skill for utilizing pictorial cues for judging depth is acquired through experience, which increases with age (Kubzansky, Rebels & Dorman, 1971). Piaget and Inhelder (1956) had shown that at the end of the sensori-motor stage of development (0-2 years) children were already in possession of a practical space that formed the basis of much of their knowledge.

Hudson (1960, 1962a, 1962b, 1967) has carried out fairly systematic studies of *verbal test* of pictorial depth perception in the context of developmental and cultural variables. His test consists of 11 outline drawings and one photograph. Six of the line drawings depict a "hunting scene" and the remaining 5 represent a "flying bird scene". The drawings in each set vary with respect to the use of the depth cues of familiar size, superimposition and perspective. The photograph is a picture of models of the hunting scene. The results indicated that the school-going samples were classified as 3-D perceivers significantly more frequently than the non-schooled groups.

There have been several criticisms and replications of Hudson's test. One of the criticisms most frequently brought against Hudson's test is that it violates the cultural context of nearly all the populations he tested (Jahoda, 1968).

Besides Hudson's test, researchers have developed other tests of pictorial depth perception. Deregowski (1968a) compared the performance of Zambian schoolboys and domestic servants, on Hudson's test and his own "construction test". Deregowski concluded that a subject cannot be classified as a 2-D perceiver of all pictorial material merely because he is a 2-D perceiver as far as Hudson's test is concerned. These results indicate *"test specificity"* in the perception of depth in picture. Deregowski et al. (1972) also showed the importance of the nature of the picture surface in depth perception. Jahoda and McGurk (1974b) introduced a new test for pictorial depth perception (see Jahoda & McGurk, 1974a; McGurk & Jahoda, 1974b) which involves *activity-based response* instead of verbal.

Development of depth perception skills have been less studied in our country. Not much is known about the factors that facilitate 3-D perception of pictures. One major limitation of most of the previous studies of pictorial depth perception is their predominant reliance either only on verbal measures or only on performance measures, which is likely to give rise to considerable errors, particularly in the case of young children,. The difficulties are that subjects, who fail to interpret Hudson's pictures in a 3-D manner, provide considerable evidence for 3-D perception on other kinds of task (i.e., of Deregowski, 1968 or McGurk & Jahoda, 1974) indicating that 3-D perception is relative to the tasks used for its assessment. "Task specificity" in performance appears to be a recurrent feature in developmental and cross-cultural studies of cognition (Mishra, 1997, 2001; Mishra, Dasen & Niraula, 2003; Mishra & Dasen, 2005; Verma, Mishra & Upadhyay, 2003).

The discussion presented above indicates that Researchers have generally used only one task (either verbal or performance), which do not produce similar results with respect to pictorial depth perception. The present study tries to examine the role of task characteristics in 3-D perception skill by using a locally developed Doll placement task (DPT). In view of the findings of other studies, it was hypothesized that children in general would appear to be 3-D perceivers more on construction than verbal task.

Method

The sample consisted of 150 school-going boys and girls between 3-12 years of age. They were selected randomly from three different schools in Varanasi city on the basis of availability of children of a particular age group. There were 15 boys and 15 girls in each age group. Thus the total sample comprised 150 children. The children belonged to five age-groups, namely 3-4, 5-6, 7-8 9-10 and 11-12 years. Thus, a 5 (age) x 2 (sex) factorial design was used in the study. There were 30 children (15 boys, 15 girls) in each age group. The children hailed almost from a homogeneous socio-economic background. The sample distribution is given in Table 1.

Table 1 The sample distribution (N=150)

Age	Boys	Girls
3 - 4 years	15	15
5 - 6 years	15	15
7 - 8 years	15	15
9 - 10 years	15	15
11 – 12 years	15	15

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Task and Procedure

Two different task /test were used in present study. The tests/tasks included Hudson's Depth Perception Test, Doll Placement Task. A detailed description of this test is given below.

Hudson's Depth Perception Test (HDPT). This test was develop by Hudson (1960) which included two sets eleven outline drawings and one photograph. In the present study, the first set of six pictures of "hunting scene" was used. Hunting scene depict a hunter with a spear in hand, a dear, and an elephant along with some other features of landscape (e.g., tree, road and hills) in a horizontal space. Keeping this fact in mind, Hudson designed these pictures to obtain the responses of observers to depth cues of size, overlap and perspective in horizontal pictorial space. Each picture in this test is similarly structured. The elephant is positioned centrally between a human figure and a deer. In this "hunting scene", the elephant is depicted smaller than the deer. This object size depth cue occurs in each of the six pictures. Pictures 2 and 3 carry the additional depth cue of overlapping. Pictures 4, 5 and 6 have perspective lines representing a road vanishing in a horizon. In all pictures the hunter's spear is aligned on both elephant and deer.

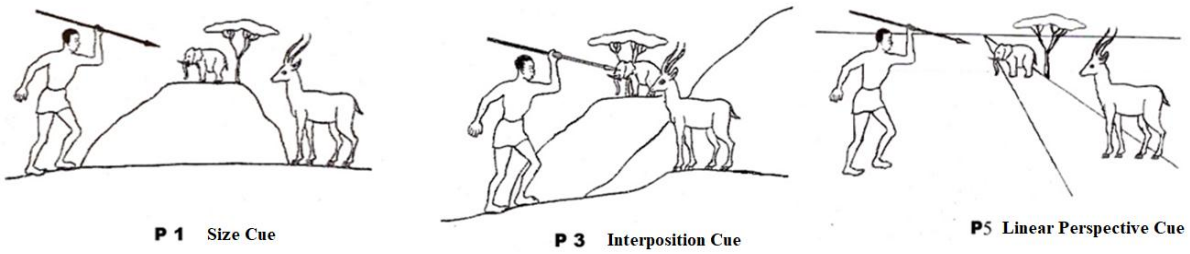

Figure.1 Hudson's Depth Perception Test (DPT)

Each picture was presented to the individual child and the following questions were asked while the child viewed the picture:

(A) What do you see in the picture?

(B) What is the man doing?

(C) Which is near the man, the elephant or the deer?

Each child was tested individually with the help of the pictures and questions regarding these pictures were asked orally in Hindi language. Although there is no time limit recommended for this test, each child was given a maximum of 20 seconds for each question on each card. Answers were recorded in the words used by children. The picture cards were shown to the child one at a time in a systematic order from picture card 1 to 6.

In response to question A, the children were required to identify each object in the picture. Responses to question B, and C in each picture were taken as indicative of two-dimensional (2-D) or three-dimensional (3-D) pictorial perception. If the child reported the hunter as aiming at the deer in response to question B, the response was classified as 3-D. If the child reported the deer to be nearer the man than the elephant in response to question C, the response was classified as (3-D). All other responses were characterized as (2-D).

Doll Placement Task: This task was modelled on Johoda and McGurk's (1974) test of pictorial depth perception. The task consisted of three sets of chromatic photographs. Each set comprised four photographs. Thus, a total of twelve photographs were developed in which a big and a small doll were represented on a plain white ground. The figures were intended to denote a big and a small doll. The dolls in the pictures were placed at various positions in a manner that allowed the use of size, superimposition and linear perspective cues of depth.

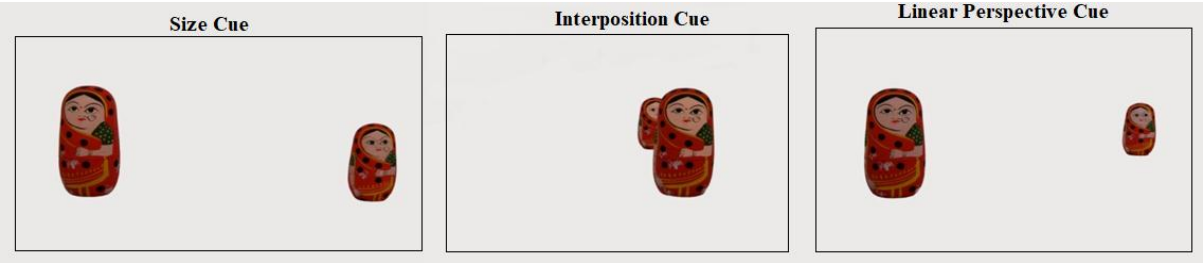

Figure. 2 Doll Placement Task (DPT)

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Two wooden dolls of big and small sizes were also prepared. A white card board was used for the placement of dolls. At each of its four corners, a black dot was made, which indicated the possible positions at which the dolls could be placed by the child. The two dolls were placed before the individual child, and asked them to place as depicted in photograph. The child was asked to make models in the same manner for all other pictures. Accuracy of responses in terms matching of pictures and models was determined. "One" score was given to each "correct" response, and a "zero" score to each "incorrect" response. The score range for the whole task was 0-12. A higher score indicated greater accuracy of depth perception.

Results

The mean scores of boys and girls on HDPT and DPT according to age levels were analyzed separately and their graphical representation were presented by figure 3 & 4 respectively.

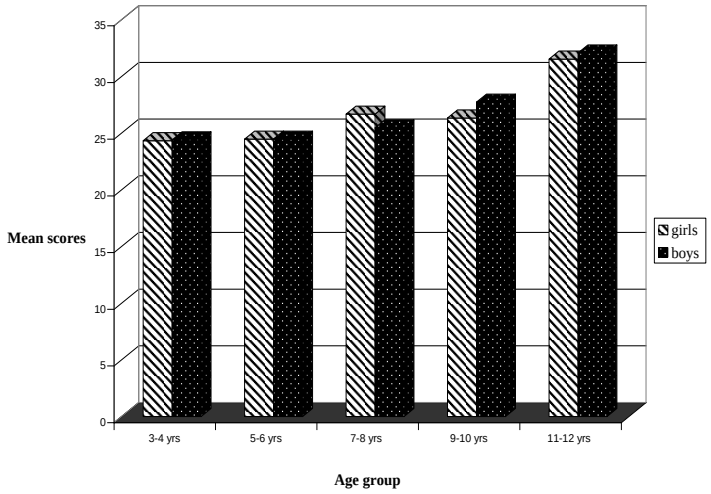

Figure 3 Graphical representation of mean scores of various groups on HDPT

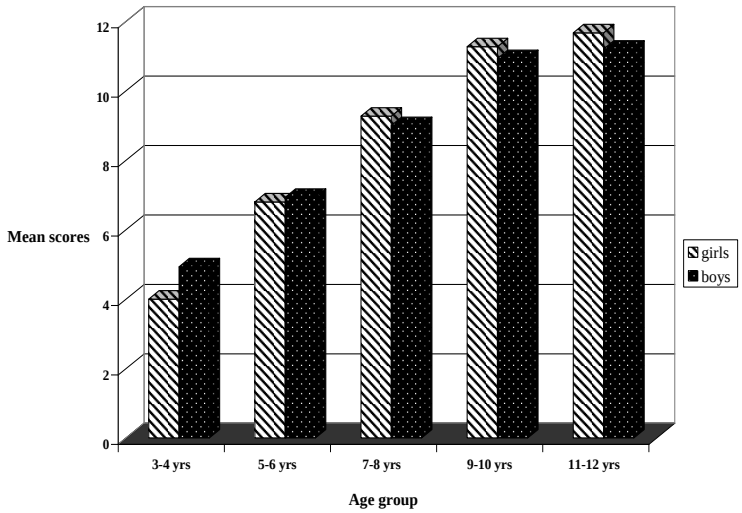

Figure 4 Graphical representation of mean scores of various groups on DPT

The mean scores obtained by different groups on both these measure reveal generally an increase in scores with the increasing age level. There are some differences in scores between boys and girls at different age levels, but they are not consistent.

The graphical figure reveals clear differences in scores according to age levels of subjects. On the other hand, difference between boys and girls at each age level appears negligible.

Task specificity:

To examine the role of task specificity in 3-D perception, children's performance on HDPT and DPT was analyzed by using the McNemar test. Since same child was tested with HDPT and DPT, their scores represented

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a repeated measure. Because more than one observation per participant was obtained and the nature of data was nominal, the McNemar test was used to examine the significance of difference in 2-D and 3-D responses. It may be observed that of the 150 participants, there are more 3-D responses 65 (43%) on DPT than on the HDPT 18 (12%). The McNemar test using binominal distribution showed a significant difference in 3-D responses between the HDPT and DPT measures, (N=150, p< .001). These results are summarized in Table 3.1 and pictorially depicted in Figures 5. and 6.

Table 3.1 Comparison of 2-D and 3-D responses on HDPT and DPT

Measures	2- Dimensional responses	3-Dimensional responses	p value
HDPT (Verbal measure)	132 (88%)	18 (12%)	.001**
DPT (Performance measure)	85 (56.7%)	65 (43.3%)	

****p<.001**

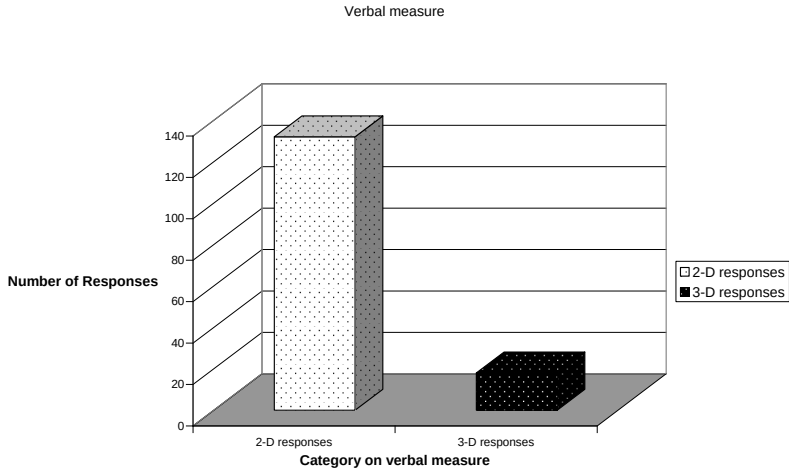

Figure.5 Bar diagram showing the number of 3-D and 2-D responses on HDPT

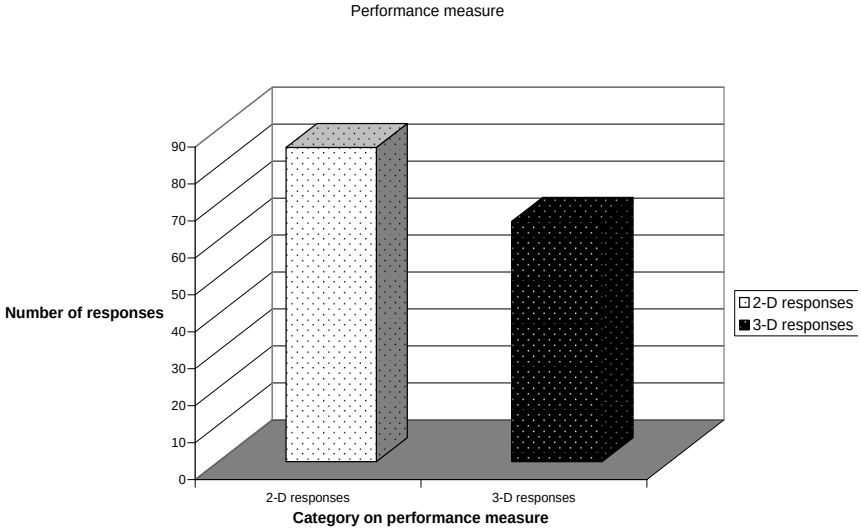

Figure. 6 Bar diagram showing the number of 3-D and 2-D responses on DPT

Discussion

The findings of the study completely support the hypothesis regarding task specificity in the perceptual depth perception skill. From the findings presented in result sections, it is also evident that there are developmental trends in the use of depth perception cues at different age levels. The phenomenon of gender difference is rejected in the reports.

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One of the major weaknesses of most of the previous studies in the field of pictorial perception has been their predominant reliance on verbal responses given by the subjects. In the case of young children this is likely to be quite restricted (Jahoda & McGurk 1974; McGurk & Jahoda 1974, 1975). In order to overcome this difficulty a new approach based on performance measures was devised. From this measure it was possible to obtain data about of children's judgment and understanding of the spatial relationships represented in pictures without seeking verbal responses. We have discussed earlier also the limitation of this approach. That children do better on one than other tasks that measure the same behavior is recurrent theme in developmental psychology under the rubric of "task specificity".

The findings of the present study provide evidence for some "task specificity" in 3-D perception of children. They reveal a significant difference between verbal and performance measures of depth perception. There were more 3-D responses 65 (43%) on DPT than on the HDPT 18 (12%). "Task specificity" in performance appears to be evident in other studies of cognitive development (Dasen & Mishra, 2010). Many children can do the task, but find difficult to explain how they did it (Mishra, Dasen & Nirula, 2003). The fact that spatial tasks are very sensitive to small changes in the display or the instructions has been found repeatedly both in infancy (Acredolo, 1990) and at later ages (Newcomb & Huttenlocher, 2005). Cottereau-Reiss (1999) indicates that minor variations in the content or procedure that do not change the formal structure of the problem sometimes have important effects on behavior, and change significantly the nature of responses.

Several developmental and cross-cultural studies of spatial language and encoding (e.g., Mishra, et al 2003; Mishra & Dasen, 2005; Verma, Mishra & Upadhyay, 2003; Wassmann & Dasen, 1998) draw our attention to this fact. It has been shown repeatedly that the same task can produce quite different results depending on the details of the procedure and the general lay out of the setting in which testing is carried out. Li and Gleitman (2002) found markedly different results depending on the availability of landmarks in the experimental setting, i.e., when the task was set inside a room with shutters closed, shutters open, or outside on the campus, or when a reference object was placed on the table.

The results obtained with HDPT and DPT regarding 3-D perception in the present study further strengthens this hypothesis. They suggest that task-specificity can be used for a finer analysis of the processes that are involved in 3-D perception of pictures. Instead of relying on a single measure, therefore, researchers should vary the task systematically.

In view of these findings it may be concluded that "Task specificity" in performance appears to be another problem not much examined in developmental and cross-cultural studies of cognition, to overcome these difficulties have developed tests, which involve activity-based responses instead of verbal. Thus, there is need to undertake a study, which focuses on the development of pictorial depth perception during the period of childhood using a range of tasks and procedures.

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