DOCUMENT RESUME

ED 167 293 PS 010 459

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TITLE A Comparison of Children's Spatial Reasoning: Rural Appalachia, Suburban and Urban New England.
PUB DATE Mar 79
NOTE 24p.; Based on thesis submitted in partial fulfillment of requirements for master's degree, Tufts University; Portions of paper were presented at the Biennial Meeting of the Society for Research in Child Development (San Francisco, California, March 15-18, 1979) ; Best copy available

EDRS PRICE MF-$0.83 HC-$1.67 Plus Postage.
DESCRIPTORS *Cognitive Development; Comparative Analysis; Concept Formation; *Elementary School Students; *Environmental Influences; *Map Skills; *Perspective Taking; Rural Urban Differences; Rural Youth; Suburban Youth; Urban Youth
IDENTIFIERS *Spatial Concepts

ABSTRACT

This study compared the developmental levels of spatial concepts in children from three different environments in the United States. Matched groups of twenty 10-year-olds were selected from a rural Appalachian community, a middle-class suburban community, and a lower-middle-class urban community, and administered a Piaget-based map drawing task. Twenty separate elements, each of which is a spatial concept applied to a map feature, were assessed for developmental level (1-6). The element scores were partitioned by individual spatial concepts, feature clusters, modal levels, and mean map drawing averages. Analyses of variance were performed on the partitioned scores to compare the groups' developmental levels. Scheffe tests for determining all possible comparisons were then performed on the partitioned scores reaching significance between the groups. Results showed that the suburban and urban groups did not differ on any of the elements of the task, and that the Appalachian children performed better than both groups on all elements. These findings support research that has demonstrated environmental influences on cognitive development. This has been interpreted as evidence that urban/suburban environments in the U.S. are not optimal for the development of all cognitive skills. (Author/MP)

A Comparison of Children's Spatial Reasoning: Rural Appalachia, Suburban and Urban New England*

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*This report is based on a thesis submitted in partial fulfillment of the requirements for the master's degree at Tufts University. The author wishes to thank David H. Feldman for his assistance. Portions of this report were presented at the meeting of the Society for Research in Child Development, San Francisco, March 1979.

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ABSTRACT

This study compared the developmental levels of spatial concepts in children from three different environments in the United States. Matched groups of twenty 10-year-olds were selected from a rural Appalachian community, a middle-class suburban community, and a lower-middle-class urban community, and administered a Piaget-based map drawing task. Twenty separate elements, each of which is a spatial concept applied to a map feature, were assessed for developmental level (1-6). The element scores were partitioned by individual spatial concepts, feature clusters, modal levels, and mean map drawing averages. Analyses of variance were performed on the partitioned scores to compare the group's developmental levels. Scheffe tests for determining all possible comparisons were then performed on the partitioned scores reaching significance between the groups. Results showed that the suburban and urban groups did not differ on any of the elements of the task, and that the Appalachian children performed better than both groups on all elements. These findings support research that has demonstrated environmental influences on cognitive develop[illegible]. This has been interpreted as evidence that urban/suburban environments in the U.S. are not optimal for the development of all cognitive skills.

One of the original studies concerning children's map drawing abilities was conducted by Piaget and Inhelder (1948). The map drawing task grew out of their broader investigation into the ontogeny of children's spatial reasoning. Piaget observed and outlined invariant developmental sequences in the acquisition of spatial concepts (e.g., projective, Euclidean, and topological concepts) and found that the map drawing exercise required an overall integration of those various spatial concepts. Piaget also proposed a developmental sequence for the integration of these concepts into a representational system, thus making the map task a useful instrument for assessing the level of a child's ability to understand and represent spatial concepts.

The present study used the map drawing task devised by Piaget and elaborated by Snyder, Feldman, and LaRossa (1976). It assessed and compared the development and coordination of various spatial concepts in children from three disparate environments in the United States: a rural Appalachian community, an urban New England community, and a suburban New England community. The purpose of the study was to determine whether differing environments, as represented by the Appalachian, urban, and suburban communities, have significant effects on individual spatial concepts and their coordination in spatial reasoning. The mapping task, which required the children to draw a map of a miniature landscape, was scored for the developmental level of the projective, Euclidean and topological concepts used in representing the features of the landscape. This empirical refinement provided a detailed set of indices for comparing particular concept levels among differing subjects and groups.

Previous comparative or cross-cultural studies concerning early to middle childhood Piagetian tasks (e.g., conservation, logic, spatial concepts) have elicited a single concession from Piaget concerning his theory of intellectual development. Piaget's concession is that research in various cultures has shown that not all developmental sequences progress at the same rate under all social conditions. Differences that have been observed usually occur at the later periods of development, leaving the early periods the most culturally uniform (Dasen, 1973).

The universality and sequentiality of Piaget's spatial reasoning concepts have been supported by an abundance of cross-cultural studies: therefore it seems justified for one to assume that Piaget has indeed described a universal developmental sequence (see Dasen, 1973; Modgil, 1976). The profusion of similar findings such as Dasen reports have led some researchers to examine environmental factors which might possibly promote or retard the development of certain cognitive abilities. Environmental impact on the development of spatial relations has been demonstrated in previous comparative research. Vernon (1966) found that Eskimo subjects perform better than West Indians and Canadian Indians on perceptual-spatial tasks. This finding is important in that it suggests that spatial reasoning can develop to a sophisticated level without formal schooling.

While there is no direct evidence in the literature that Appalachian culture would enhance the development of spatial reasoning, it could be argued that an increased need for geographical orientation among people who live in an underdeveloped terrain might foster the development of at least some aspects of spatial reasoning. The most likely spatial concept that would be affected by

environmental emphasis on orientation would be proportion (Euclidean concepts). Proportion in the map drawing task emphasizes the Euclidean reference system that enables one to compare positions and distances simultaneously (Holloway, 1967). The ability to reference position and distance would be much more important in an environment that is void or lacking in a spatial grid (like a city block) or continuous and obvious landmarks (such as urban/suburban buildings). The Appalachian environment has a more subtle geographical grid and fewer prominent or consistent landmarks, a phenomenon which might enhance a child's ability to orient by position and distance.

In a study of children's conception of territory using Piaget's spatial stages, Stoltman (1972) found all of his North Georgian subjects were significantly behind the expected Piagetian stage levels regardless of sex, race, or urban-rural residence. While Stoltman attributed no significant differences to the main effects of sex and rural-urban residence, it is possible that the North Georgian rural environment is not sufficiently different from the urban environment to have produced a main effect. The rural-urban distinction could also have been confounded if both populations had easy or frequent access to both environments. Page (1973) studied conservation of distance among Zulu youths and suggested that rural youths are more likely to retain a topologigal concept of space. Johoda, Deregowski and Sinha (1974) investigated whether a predominance in topological orientations to spatial-perceptual problems is culturally specific. Samples were drawn using four- to twelve-year-olds from Hong Kong, India, Scotland, and Zambia. No significant differences were found in cultural or age groups that suggested a preference for topological responses.

It is not clear from the available date whether environment significantly effects the progression from topological concepts to Euclidean concepts. The spatial concept in the map drawing task that emphasizes the topological to

Euclidean progression is arrangement. Arrangement stresses topological concepts in the lower levels of development and a Euclidean system of coordinates in the advanced levels. If Page's evidence that rural youths are more likely to retain topological concepts is true, Appalachian children would not be expected to perform as well as urban or suburban children on the arrangement concepts of the map drawing task; but if Jahoda et. al. and Stoltman's comparative studies are supported there should be no difference between urban, suburban, and rural groups.

As regards the other areas in the map drawing task, perspective and symbolism, there is no comparative evidence that differing environments might facilitate or impede their development. The concept of symbolization, though, is probably most easily influenced by direct teaching. A child can be shown how to construct a key for the map or told to label figures which would increase his performance on the symbolization task. There is no reason to presume that any of the schools have stressed this aspect of mapping in their curriculum.

Other data that could help predict differences between the Appalachian children and suburban or urban children can be found in comparative studies which consider socioeconomic status and cognitive development. Children from lower socioeconomic families evidence lags in their performance on many developmental tasks (Modgil & Modgil, 1976). This notion was supported in Stoltman's study of spatial concepts and in Feldman's (1971) study of mapping concepts. Since Appalachia is economically depressed by almost any standard, the overall effect of this on the development of spatial concepts was hypothesized to be detrimental even if one or two aspects might be enhanced by the environment.

The comparative aspect of this study was to test whether the rural Appalachian environment is significantly different than the Northeast urban or suburban environment in affecting the development and coordination of spatial concepts in map drawing. The goal of this study was primarily descriptive in that it elucidated similarities and differences between environmentally diverse populations. The environmental effects were determined by comparing: 1) the overall developmental level; 2) the developmental level of individual concepts within spatial reasoning concepts; and 3) the representation of these concepts (e.g., symbolization).

METHODS

The Task: The map drawing exercise required each child to draw a map of a miniature landscape which contains houses, roads, trees, a hill, a lake, and a bridge. Scoring of the maps was done by determining the level or stage of performance on each of four feature/clusters according to four main concept areas: perspective, symbolization, arrangement, and proportion. The concept areas were operationalized from Piaget's spatial concepts such that perspective emphasizes projective concepts, arrangement emphasizes topological concepts in the lower levels and Euclidean concepts in the higher levels, proportion emphasizes a Euclidean reference system, and abstraction/symbolization denotes the representational system. Feature clusters consist of objects which share logical and physical properties; e.g., hill, bridge, island, and other elevated land. Each map provides twenty scores; the four concepts as they are applied to the five feature clusters (buildings, elevated areas, flat surfaces, incidental features, and an inclusive score of the concept as applied to the map as a whole). These twenty concept/feature combinations are termed "elements."

Each of the twenty elements has scores that range from levels 1 - 6, corresponding to Piaget's six stages. The map is scored for: 1) developmental level on each element (spatial concept applied to a feature cluster); 2) modal level of the twenty elements (Mode); 3) mean average of the element levels (MDA); 4) the amount of variation from the mode (level mixture); and 5) the direction in which most of the elements vary from the mode (positive or negative bias).

The maps were scored by trained judges. Interjudge agreement on randomly selected samples was at least 80% for all 20 element scores.

Setting: Children were selected from three communities: Cameron, West Virginia (rural); Branford, Connecticut (suburban); and Somerville, Massachusetts (urban, greater Boston area).

Rural: The rural children were from Marshall County, West Virginia. Marshall County lies in the northern part of West Virginia and is characterized by hilly terrain and sparse habitation. Most of the inhabitants engage in farming for either full or partial subsistance. The majority of the salaried jobs are blue-collar.

The community of Cameron, with a population of approximately 500, is one of a few small towns which lie in the larger valleys. Cameron provides a consolidated school system for the children of southern Marshall County, many of whom live an hour's bus ride from school. The Cameron School is a recent development (Spring, 1978) in the education of Marshall County children. Previously all of the elementary school children attended one- and two-room schools more proximal to their homes.

The school experience and occastional shopping trips to other communities are often the only exposures these children have to individuals other than family members or close neighbors. Geographic barriers and distances are not

the only isolating factors. Extremely close family ties and reluctance to leave Appalachia are traits which have helped to maintain the cultural distinctiveness and isolation of Appalachia life (Loof, 1971).

Suburban: The suburban children were selected from an integrated public middle school in Branford, Connecticut. Branford is a suburb of New Haven and can be characterized as middle- to upper-middle class, with a mixture of working class and professional families.

Urban: The urban children were selected from a parochial school in Somerville, Massachusetts. Somerville is predominately a blue-collar community, located in the greater Boston area.

Subjects: Tweny 10-year-old subjects from the 5th grade were selected from each community. Equal numbers of males and females were selected. Ten-year-olds were chosen because previous research using the map drawing task had determined that children of this age range are roughly in the middle of the developmental sequence for spatial concepts (Snyder & Feldman, 1977).

The children from Cameron (rural) were initially chosen on the basis of how far they lived from Cameron. After the most rural children were selected to draw maps, the drawings of 10 males and 10 females were randomly selected to form the representative comparison group for this setting.

Map drawings from Branford (suburban) has been collected in 1974 for a separate study which used the same mapping task with 5th graders (Snyder, Note 2). A group of 20 maps were randomly drawn from the sample to comprise the suburban comparison group.

The Somerville (urban) maps were collected for a separate study in 1978 utilizing the same mapping task with 5th graders (Levene, Note 3). A matched sample of 20 maps were randomly drawn for the urban comparison group.

Procedure: The administration of the map drawing task was straightforward and uncomplicated. The subjects were presented with a miniature landscape (3' X 3') comprised of various features (e.g., hill, lake, houses, etc.). The subjects were given a square piece of white paper, 21.5 X 21.5 cm, and a pencil, with the verbal instructions to make a map of the model. The subjects drew while sitting in their seats but they were free to walk up and inspect the model as often as needed. The subjects could construct the maps as they wished and could take as much time as they needed.

Analysis of Data: A series of t tests comparing mean map drawing averaged of the male and female children from each matched group indicated no significant sex differences, thus enabling the groups to be collapsed for all analyses. The three groups of subjects were then compared on the four spatial concepts: 1) arrangement; 2) proportion; 3) perspective; and 4) abstraction/symbolization. A Scheffe test for all possible comparisons between group means was then performed on the anovas reaching significance to ascertain the manner in which the groups differed.

Additional analyses of variance were performed to ascertain differences between spatial concepts within each of the comparison groups. A Scheffe test was then performed to determine which concepts were sifnificantly different within each comparison group.

RESULTS

Three comparison groups of children - rural, suburban, and urban - were compared for developmental leve on the four spatial concepts. Three comparisons reached significance among the groups (critical value, $F(2,57) = 5.10$, $p < .01$);

the concept not reaching significance was arrangement (see Table 1). A Scheffe test was performed on the concepts which demonstrated overall significant differences among groups on the analysis of variance (see Table 2). The suburban and urban groups were not significantly different on any of the spatial concepts. The developmental level of the rural group was significantly higher than both the urban and suburban group on proportion. The developmental level of the rural group on perspective and symbolization was significantly higher than that of the suburban group.

To determine the homogeneity of developmental level achieved across the four spatial concepts, an analysis of variance was performed for each comparison group. All three groups demonstrated a significant difference in developmental level among the various spatial concepts (critical value, $F(3,76) = 2.76$, $p < .05$) (see Table 3). A Scheffe test was performed on each group with identical results (see Table 4). In all the groups the proportion level was significantly lower than all other concepts (arrangement, perspective, and abstraction/symbolization). No other contrasts reached significance.

DISCUSSION

The present study explored the possiblity that the developmental level of spatial concepts as measured by map drawing can be affected by the child's environment. The study's findings were that significant differences existed in spatial reasoning among same-age children living in three different environments within the United States. These findings support the broad body of research that caused Piaget to acknowledge that social/environmental conditions can and often do affect the rate of intellectual development. In this study the

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particular developmental sequences that were affected by the differing environments were spatial concepts and their integration into a representational form, i.e., a geographic map.

Previous research indicated that the rural children would not perform as well overall as the urban and suburban children. Not only was this hypothesis not supported, but the converse was found: the rural children exhibited a significantly higher map drawing average than both the urban and suburban groups. There were no significant differences between the urban and suburban groups (see Figure 1). The urban and suburban children demonstrated almost identical developmental levels on all items of the task, with none of the differences reaching significance.

These data indicated that differences which might have existed between the suburban children's environment and the urban children's environment (e.g., physical surroundings, socio-economic status of the families, quality of the schools, etc.) were not sufficiently important to affect the development of spatial concepts as measured by the map drawing task.

The rural environment, in contrast to the urban and suburban environments, seemed to foster or accentuate the development of these spatial concepts in the comparative sample of 5th graders. This finding supports Vernon's (1966) research suggesting that spatial reasoning can develop to a sophisticated level because of environmental influences that are outside the area of formal instruction. While Vernon asserted that the development of spatial concepts among Eskimo children is enhanced because of the training they received in tracking and hunting, there did not appear to be a similarly forceful demand put on Appalachian children to develop their spatial reasoning. Whatever environmental conditions enhance spatial reasoning in Appalachian children,

it is certainly more subtle than the hunting-survival demands that Vernon suggests for the Eskimos.

Contrary to previous Piagetian research concerning socio-economic status and spatial concept development (Feldman, 1971; Stoltman, 1972), the rural children did not exhibit a developmental lag, but out-performed other groups. Similarly these findings contradict Page's (1973) findings that rural children are more likely to retain topological concepts of space (lower level) than Euclidean concepts (higher level). While it may not be clear what aspects of the Appalachian environment affects the enhanced development of spatial reasoning in children, it is clear, contrary to expectations, that their development was significantly more advanced than that of the urban and suburban children.

A limitation of the present study is that the level of map drawing in children other than 10-year-olds may not reveal the same comparative findings. Without knowing longitudinal or adult developmental levels for the mapping task from each of the environments it can not be determined whether the advantage the rural children demonstrate is temporary or whether it reflects a superior level of spatial reasoning that will endure. At the time of this study there existed no known normative data on the developmental levels of adults on the map drawing task.

A separate analysis of each comparison group indicated significant variation in developmental level for the differing spatial concepts. Within each group (urban, suburban, and rural) the findings were identical: proportion was significantly lower than the other three concepts - arrangement, perspective and abstraction/symbolization. This finding indicated that the task items were equally demanding relative to each other for all the groups. Proportion was the least developed concept for each group and seems to represent a developmental lag across the groups.

SUMMARY

The map drawing task was chosen as an exploratory tool in this study so that the author could evaluate the performance of children from differing environments of specific spatial concepts. The hypotheses were that the Appalachian children would perform better on proportion; that there would be no difference on arrangement; and that the suburban and urban children would perform better on the overall mapping averages. Instead, the study showed that the Appalachian children outperformed the comparison groups on every aspect of the mapping task.

The developmental levels of the spatial concepts varied within each comparison group indicating a significant amount of level mixture. The variation in spatial concept development was similar in all three groups thus demonstrating that the relative difficulty of each item was maintained regardless of the overall developmental level.

These findings demonstrate that spatial reasoning is better developed in Appalachian 5th graders than in similar children in a middle-class suburban community and a lower-, middle-class urban community. The implications are that 1) subgroups within American culture can show wide variation in cognitive performance, and that 2) middle-class urban/suburban environments are not optimal for the development of all cognitive skills.

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Table 1: Variance of Spatial Concept Means Between Groups

Spatial Concepts	Groups[a] Rural	Suburban	Urban	F
Arrangement	3.49	3.27	3.21	2.00
Proportion	3.09	2.75	2.56	9.00*
Perspective	3.66	3.15	3.31	6.75*
Symbolization	3.73	3.19	3.43	5.72*

df= 2,57

*$p < .01$

[a]n=20 in each group.

Table 2: Scheffe Test for Contrasts Between Groups on Spatial Concepts

Spatial Concepts **	Groups[a] SU-U	R-SU	R-U	Critical Value	$p < .05$
Proportion	.19	.34*	.53*	.32	R>U, SU
Perspective	.16	.51*	.35*	.35	R>U, SU
Abstraction	.24	.54*	.30	.40	R>SU

[a] R = Rural, SU = Suburban, & U = Urban

*$p < .05$

**Arrangement $p > .05$ (see Table 1)

Table 3: Variance of Spatial Concepts Within Groups

Groups	Spatial Concepts				
	Arrangement	Proportion	Perpective	Abstraction	F
Rural	3.49	3.09	3.66	3.73	7.00*
Suburban	3.27	2.75	3.15	3.19	4.86*
Urban	3.21	2.56	3.26	3.43	16.94*

df = 3,76

*p < .05

ble 4: Scheffe Test for Contrasts Within Groups on Spatial Concepts

oups	Spatial Concepts[a]												
	I-II	I-III	I-IV	II-I	II-III	II-IV	III-I	III-II	III-IV	IV-I	IV-II	IV-III	p <.05
ral	.40*	-	-	-	-	-	.17	.57*	-	.24	.64*	.07	II<I,III & IV
burban	.52*	.12	.08	-	-	-	-	.40*	-	-	.44*	.04	II<I,III & IV
ban	.65*	-	-	-	-	-	.05	.70*	-	.22	.88*	.17	II<I,III & IV

<.05, Critical Value: Rural=.309, Suburban=.302 & Urban=.265

= Arrangement

I = Proportion

II= Perspective

V = Abstraction

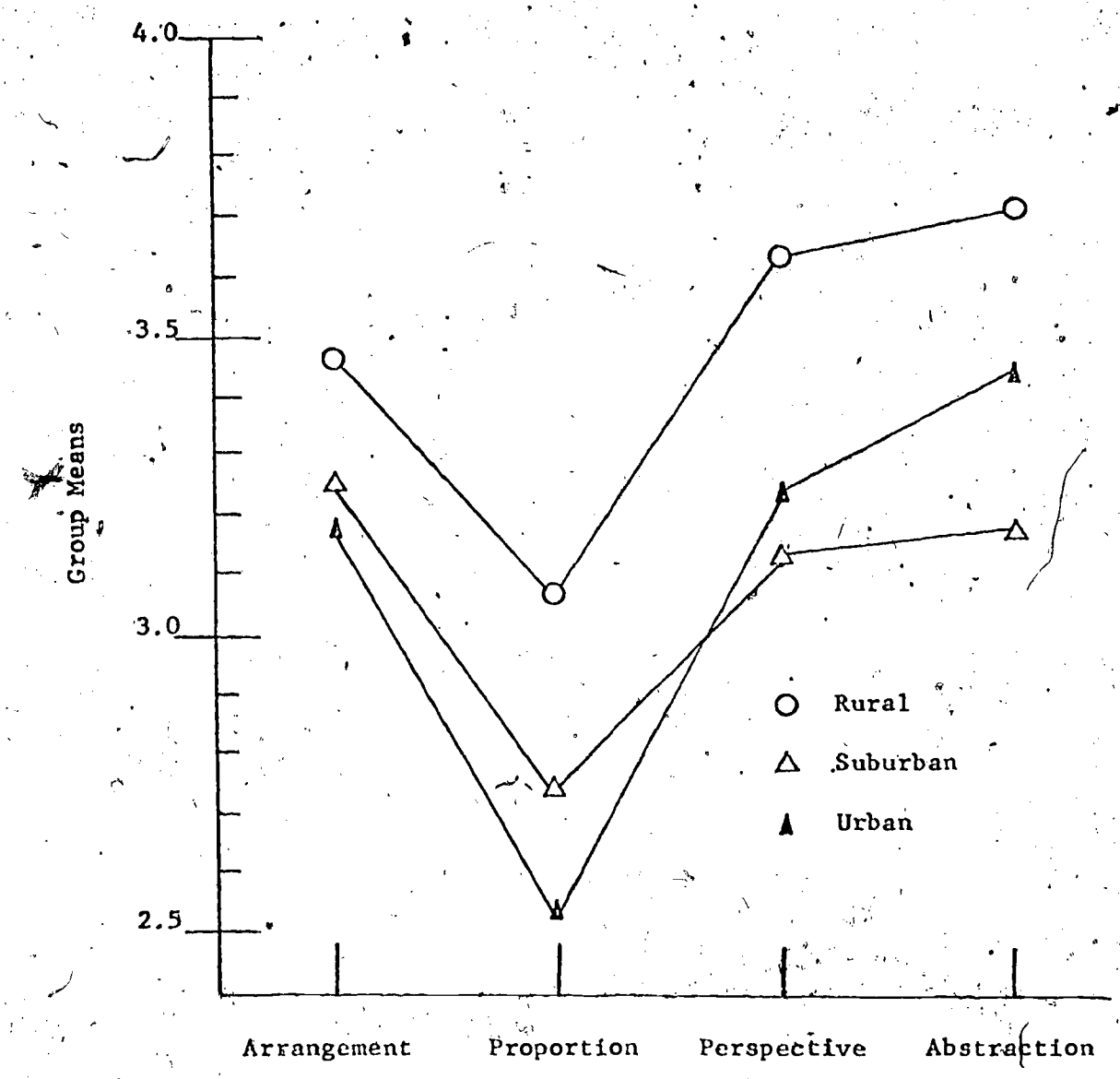

Figure 1: A Comparison of Spatial Concept Means