DOCUMENT RESUME

ED 446 055 SP 039 487

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TITLE	Spatial Visualisation Ability and Learning Style Preference of Low Achieving Students.
PUB DATE	2000-00-00
NOTE	13p.
PUB TYPE	Reports - Research (143)
EDRS PRICE	MF01/PC01 Plus Postage.
DESCRIPTORS	Academic Achievement; *Brain Hemisphere Functions; Cognitive Ability; *Cognitive Style; Elementary Secondary Education; Foreign Countries; *Spatial Ability; Students; *Visualization
IDENTIFIERS	Singapore

ABSTRACT

This paper explores the role of one cognitive style, spatial visualization, which research suggests correlates highly with student achievement. The study focuses on: whether students with high, average, and low spatial visualization ability differ in their preferred learning modes (concrete experience, abstract conceptualization, reflective observation, and active experimentation); whether these three groups of spatial visualization ability differ in their perception and processing dimensions; whether these three groups differ in their preferred learning styles (assimilator, converger, accommodator, and diverger); and what the relationship is between learning styles and brain hemisphericity. Three instruments (Kolb's Learning Style Inventory, McCarthy's Hemispheric Mode Indicator, and Dailey's Spatial Visualization Test) were administered to 192 students enrolled in a training center in Singapore. Statistical analyses revealed that students do not differ significantly in their learning modes and hemispheric preference across the three spatial visualization ability groups. Results also indicate that there are no significant differences in learning style preferences from the three brain dominance groups. The general patterns are not consistent with earlier research studies. (Contains 23 references.) (Author/SM)

Spatial Visualisation Ability and Learning Style Preference of Low Achieving Students

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Abstract:

Studies on cognitive style preferences among students have shown strong relationships between a student's learning style and hemispheric mode preference. This paper explores the role of another cognitive variable, spatial visualisation which according to Battista (1992) correlates highly with achievement. This study attempts to answer the following questions: 1) Do subjects with high, average and low spatial visualisation ability differ in their preferred learning modes (concrete experience, abstract conceptualisation, reflective observation and active experimentation). 2) Do these three groups of spatial visualization ability differ in their perception and processing dimensions. 3) Do these three groups differ in their preferred learning styles (assimilator, converger, accommodator and diverger). 4) What is the relationship between learning styles and brain hemisphericity.

Three instruments (Kolb's Learning Style Inventory, McCarthy's Hemispheric Mode Indicator and Dailey's Spatial Visualisation Test) were administered to 192 students enrolled in a training center in Singapore. Statistical analyses revealed that students do not differ significantly in their learning modes and hemispheric preference across the three spatial visualisation ability groups. Results also indicate that there are no significant difference in learning style preferences from the three brain dominance groups. The general pattern is not consistent with earlier research studies. Several possible explanations are discussed and suggestions proposed for future research.

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Studies linking spatial ability to brain hemisphericity have found that this specific cognitive ability is predominantly a right brain function. (Saleh & Iran-Nejad, 1995; McCluskey, 1997). Culture and practice are noted to be relevant variables encouraging this relationship. When a large number of spatial ability tests were analysed, three separate factors were identified: spatial perception which requires subjects to locate the horizontal or the vertical while ignoring distracting information; mental rotation which tests the subjects' ability to imagine how objects will appear if they are rotated and spatial visualisation which refers to the subjects' ability to do complex multistep processing of spatial information. A spatial task could tap on the subject's left or right brain, or both, depending on the actual mental manipulation.

Kolb (1984) noted that left brain dominant people use a cognitive style that corresponds to abstract conceptualisation, preferring abstract, symbolic, analytical, sequential and verbal information processing. Right brain dominant people prefer concrete, holistic and spatial processing, similar to the concrete experience learning style. Research on learning styles and hemisphericity has been in the context of performance in specific academic areas as found in Kolb's (1981) large scale survey on graduate students and faculties in American colleges and universities. In mathematics, high achievers were found to be more abstract and low achievers to be more concrete and in the verbal processing domain, high achievers were both more reflective and more active than low-achieving students.

A study by Titus, Bergandi & Shryock (1990) on 306 high school adolescents and their overall achievement indicated that the slow track learners were less abstract than the fast track learners while the fast track and slow track students did not differ in the concrete dimension. Heng & Wong (1993) found that low achieving gifted students show a significant preference for active experimentation while the high achieving gifted students show a preference for reflective observation. Similarly, Hainer (1987) found that, among 256 high students, more reflective high school students performed better in reading and Emch (1990) found academically successful home economics students to be more committed to reflective observation.

Using the Cognitive Laterality Battery, Yeap (1987) examined the learning styles of 284 high school students and found that high achievers were more left brained dominant while low achievers were more right brained dominant. High achievers also performed better than low achievers in both left and right brained dominant tasks. Lim (1987) on the other hand, in his study on the relationship between hemisphericity and achievement level of adolescents, found that integrated-brained students and right-brained students performed better and showed better spatial visualisation ability than left-brained and mixed brained students in geometry. The inconsistent results from existing literature on cognitive ability and learning styles can be due to the different instruments used

In a number of research studies exploring the relationship between spatial visualisation and academic learning ability, significant sex differences were found for different ability groups in chemistry and mathematics. For chemistry, findings show that students in the low spatial group scored significantly lower on the organic chemistry examinations than students in the high spatial group. The high spatial students made more use of drawings than the low spatial students on questions that asked for drawings and also on questions that did not ask specifically for drawings. (Pribyl & Bodner, 1985). Similarly, in another study, students with high spatial ability scores outperformed students with low spatial ability scores and spatial ability is correlated with success in chemistry. (Carter, 1985).

Results show small but consistent gender differences, with males scoring slightly higher than females in spatial visualisation. (Tohidi, 1986; Baker & Belland, 1988). Males and females differ in spatial visualization and in mathematics performance but they did not differ in logical reasoning ability or in their use of geometric problem solving. (Battista, 1990). In solving word problems and fraction problems, it was concluded that low spatial visualisation skill may be more debilitating to girls' mathematical problem solving than to boys. (Fennema & Tartre, 1985). Males were also more adept at identifying and learning shapes than females. (Locklar, 1990).

One finding revealed nonacademic activities seemed to have the most positive significant relationship to spatial visualisation ability for men but not for the women tested.(Deno, 1995). A series of three studies found that increased age was associated with lower levels of performance on tests of spatial visualisation by adults with extensive spatial visualisation experience and it was suggested that information processing and naturally occuring learning experience are important sources of individual differences in spatial visualization ability. (Salthouse, 1990).

This study explores the relationships between spatial ability and learning style preferences of students in a hospitality training center. Important factors such as the perception and processing learning modes will be measured by Kolb's Learning Style Inventory (1985). Hemisphericity and spatial ability will be measured by McCarthy's Hemispheric Mode Indicator (1986) and Dailey's spatial visualization test (1965) respectively.

Methodology

173 students (54% males and 46% females) were administered the Learning Style Inventory (Kolb,1985); Hemispheric Mode Indicator (McCarthy, 1986) and the Spatial Visualization Test (Dailey, 1965) which was used to classify them into three spatial ability groups .

The following hypotheses are examined:

1. Students with higher spatial ability will have a higher abstract conceptualization score and lower concrete experience score along the perception dimension. than students with lower spatial ability.
2. Students with higher spatial ability will have a higher reflective observation score and lower active experimentation score along the processing dimension than students with lower spatial ability.
3. Students with higher spatial ability will have a higher assimilator learning style and lower accommodator learning style than students with lower spatial ability.
4. Students with higher spatial ability will have a higher left brain preference than students with lower spatial ability.
5. Students with a high left brain preference will have a higher assimilator learning style than students with a high right or whole brain preference.

Instrumentation

Kolb's Learning Style Inventory LSI (1985)

This is a 12 item sentence-completion questionnaire based on Kolb's theory of experiential learning. For each item, subjects had to rank four options that represent their preferred learning modes across learning situations. The four learning modes identified are concrete experience, reflective observation, abstract conceptualisation and active experimentation. A combination of scores result in four learning styles; accomodator, converger, assimilator and diverger. Kolb found test-retest reliability of the four modes to range from 0.74 to 0.86

Hemispheric Mode Indicator HMI (McCarthy 1986)

This 32 item checklist measures a subject's hemispheric preference in information processing. Three categories of preference are used in this study: left-brain, whole-brain and right brain. Test-retest reliability is 0.9 according to Cronbach's alpha.

Dailey's Spatial Visualization Test SVT (1965)

This 30 item test measures a subject's ability to visualise geometric objects presented in 2 dimensional drawings, as they would appear in three dimensional space. Test reliability estimates have been reported to be between 0.85 and 0.93

Results and Discussion

1. ANOVA revealed that students with high spatial ability do not differ significantly in their scores in any of the four learning modes: abstract conceptualisation (AC) reflective observation (RO) abstract conceptualisation (AC) and active experimentation (AE) compared to students with average or low spatial ability. In addition, the composite scores for the perceiving or processing dimension indicate that there is no significant difference among the three spatial ability groups. (Figure 1 and Figure 2)

2. The majority of high and average spatial ability students are mostly assimilators while most of the low scorers are accomodators. According to Kolb's theory assimilators prefer reflective observation over active experimentation and abstract conceptualisation over concrete experience. In the spatial test, the subjects were not allowed to physically manipulate the two dimensional representations of three dimensional geometric figures. (Figure 3)

3. There appears to be more left brain dominant subjects among the low spatial ability group. Studies have shown that spatial ability is primarily a right brain activity. (Halpern 1992). Since the spatial tasks in this study favor left brain function, it is expected that there are more high scorers among them . However there are more high spatial ability students among the right brain group. (Figure 4)

4. Assimilators and convergers seem to be predominantly left brain while accomodators and divergers seem to be predominantly right brain according to Kolb (1981) . In this study there are clearly more assimilators among left brain subjects. This is consistent with McCarthy's (1986) findings. The preference for a logical approach to learning is associated with both left brain dominant subjects and with assimilators. Accomodators tend to be whole or right brain. (Figure 5)

Conclusion

The results did not reveal any significant difference between the three spatial ability groups in terms of learning modes. It appears that spatial ability is quite independent of learning modes (concrete, abstract, reflective or active), learning dimensions (perception and processing) or learning styles (accomodator, assimilators, convergers or divergers). Some pattern however seems consistent. Students who are high in spatial ability tend to be assimilators and low scorers on spatial ability tend to be accomodators. Whole brain subjects have a disproportionately higher number of low spatial scorers among them.

The sample in this study comes from a student body in an educational system which emphasizes the left brain mode of teaching and learning for a long time. This could have explained some of the results in the study. It is important to combine both modes and integrate them into the current school curriculum. The need for more visual information to be used in classroom instruction and more hands-on or experiential approach is called for. Matching instructional method with more visual components could assist those who prefer the concrete style of learning. Matching teaching style to students' learning styles does enhance academic success (Susabda 1992) and a change in evaluation criteria and instructional methods may enhance some learning styles not benefiting from traditional manner of assessment.

Other key instruments for measuring the variables in this study could be used. It is suggested that the Witkin's Embedded Figure Test (1971) for spatial ability and Torrance's Style of Learning and Thinking (1978) for measuring hemisphericity be considered.

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Mean Scores of Concrete Experience and Abstract Conceptualization

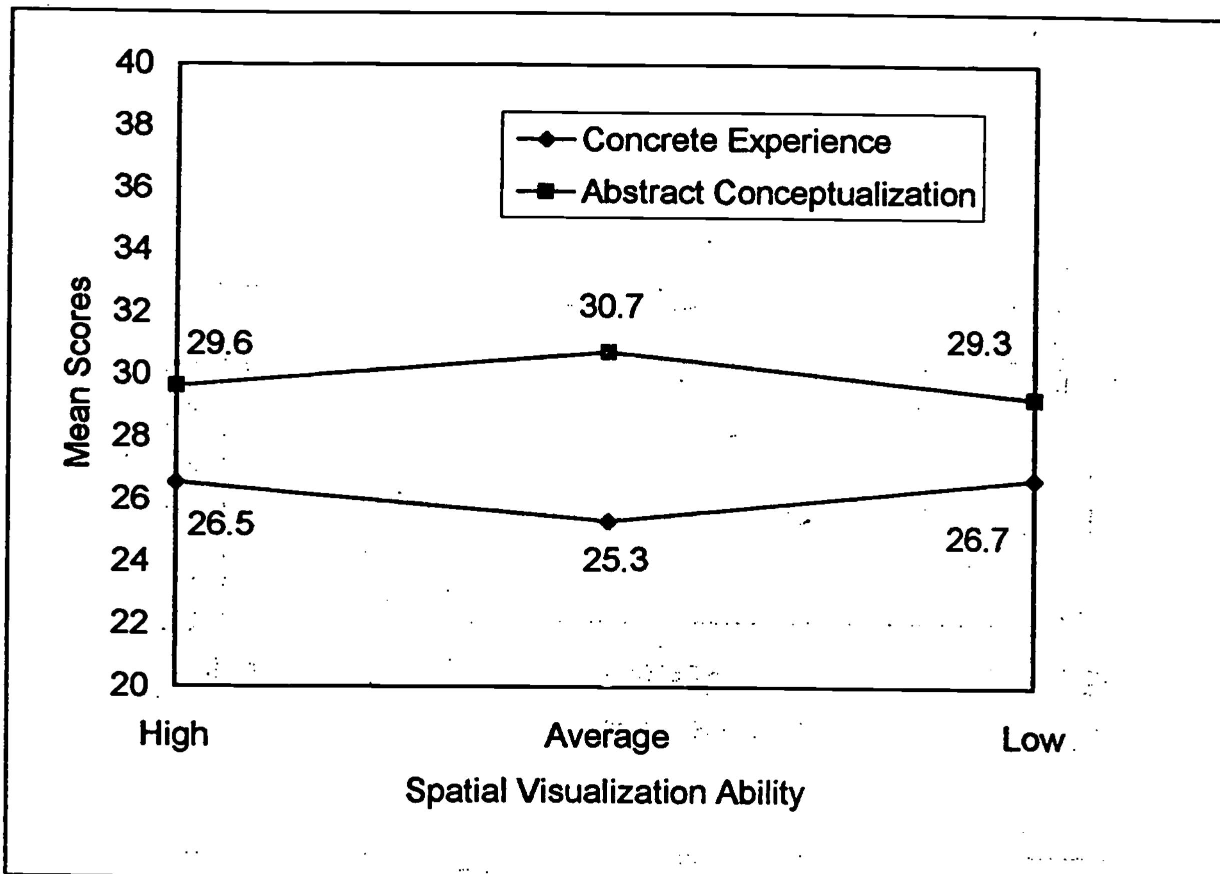

Figure 1

Mean Scores of Reflective Observation and Active Experimentation

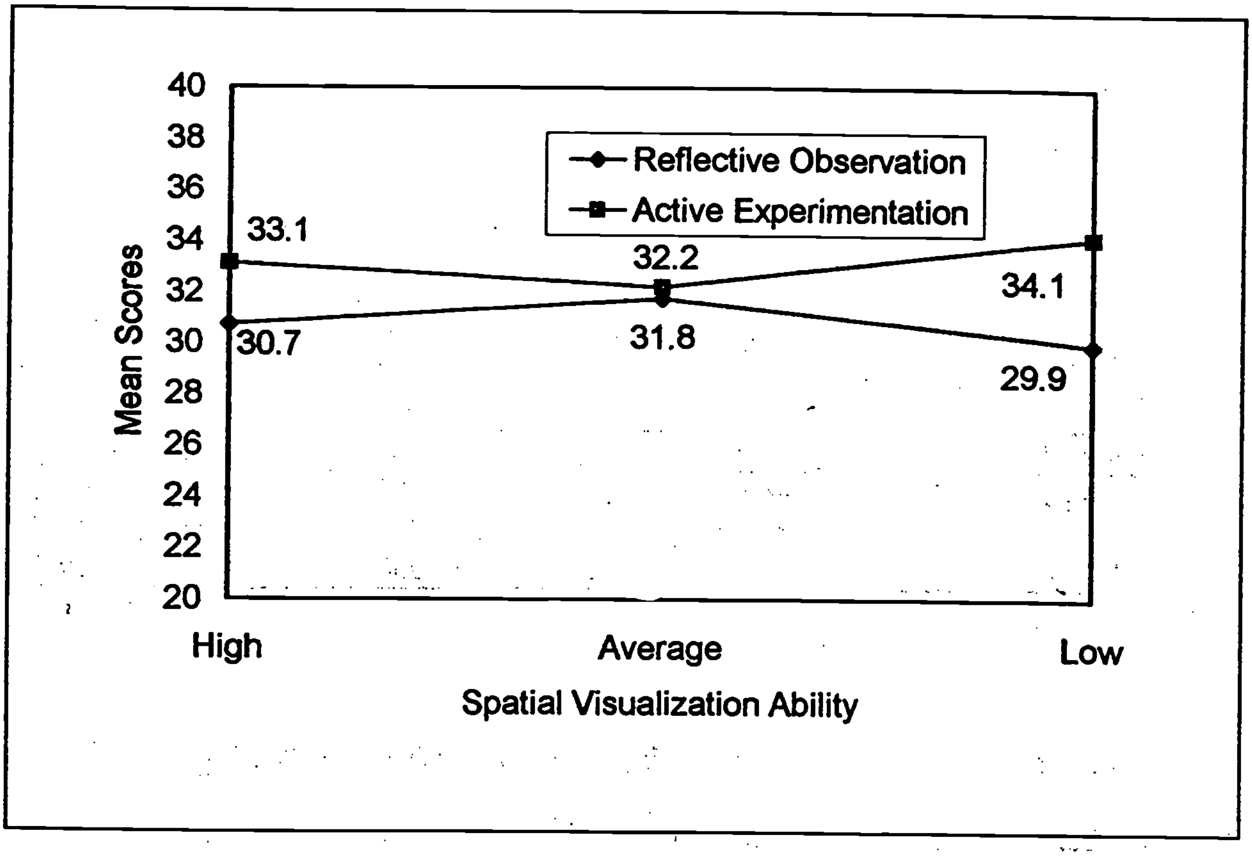

Figure 2

Percentage Distribution of Spatial Ability among the Four Learning Style Types

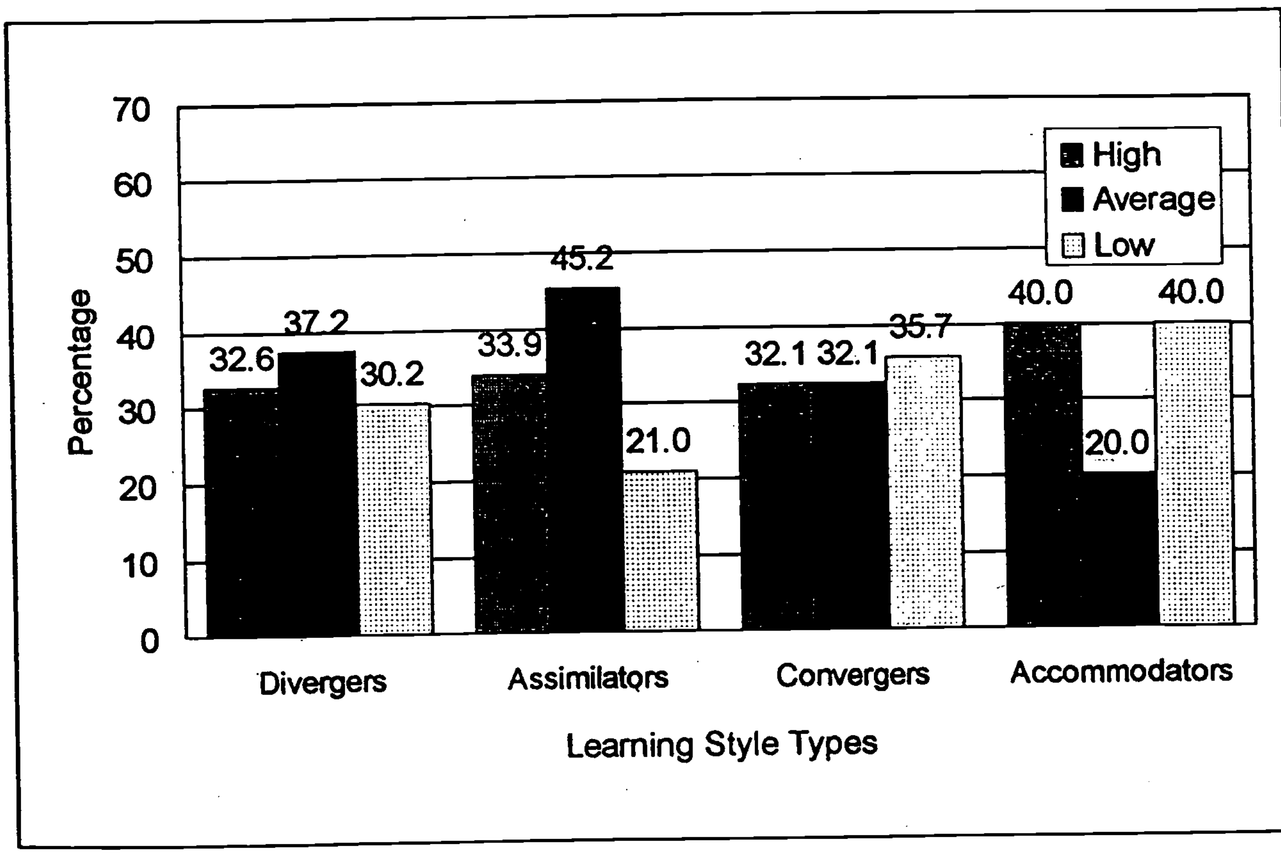

Figure 3

Percentage Distribution of Hemispheric Preferences among High, Average, and Low Spatial Ability Groups

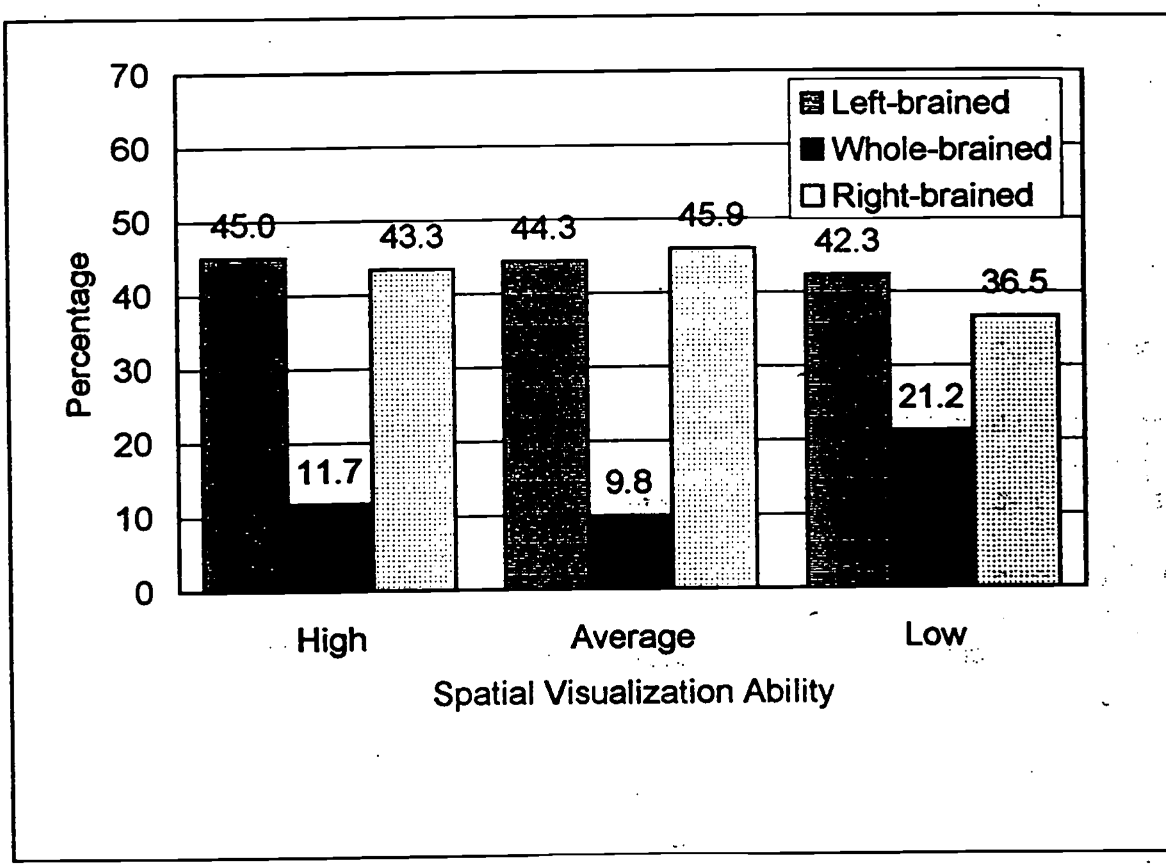

Figure 4

Percentage Distribution of Hemispheric Preferences among the Four Learning Style Types

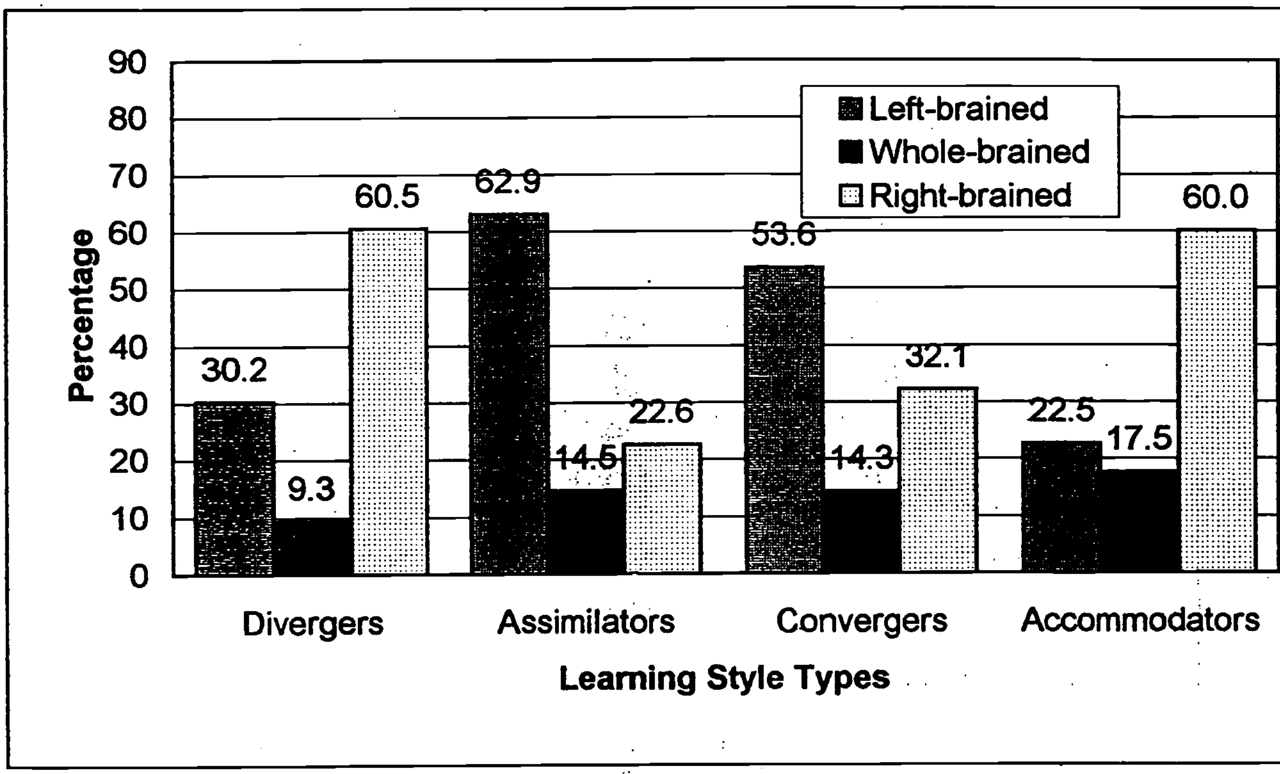

Figure 5

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