Gender Differences in Spatial Ability: Is There a Difference In Children ?

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Is There a Difference Between Gender on Spatial Ability in Children?

This literature review considers research done on testing spatial ability between age levels and gender. Spatial tasks are outlined in regard to the type of mental processes involved in testing. The nature of any gender differences in spatial ability is explored and theories that pertain to cause and prediction are reviewed. Theories include socialization, biological and environmental,which offer reasons for spatial differences between gender favoring males. Spatial ability is not a unitary concept but rather is composed of different aspects , one classification includes three areas: mental rotations ,spatial perception and spatial visualization, (Voyer & Voyer, Bryden,1995). Mental rotation tasks only require a mental visualization component, however spatial perception and spatial visualization both require dual mental processes and a more complex cognitive level. Spatial perception is defined as the ability to determine spatial relations through distracting information. Mental rotation is defined as the ability to rotate quickly and precisely two or three dimensional figures , through imagination. Lastly, spatial visualization is defined as the ability to manipulate complex spatial information when several stages are necessary to arrive at the correct solution.

Multiple studies have been done that show gender differences in spatial ability ,of males outperforming females, (Gittler & Vitrouch,1994; Halpern,1997; Kirmura,1992). The largest significant differences have been found in the purberty to adult range, with smaller significant differences in the preadolescent range favoring males, (Newcombe, Dubas & Judith 1995) range favoring males.Very few significant differences have been found in the age range up to preadolescence. It has been suggested that differences are possibly present in the young age group up to the preadolescent period, but haven't been detected, (Bryden, Voyer & Voyer ,1995). The reason given was that children have a less advanced cognitive ability, than age groups preadolescent to adult and some tasks such as spatial visualization and spatial perception require dual processes and a larger working memory capacity than for example, mental rotations .

Children have been tested on spatial perception as early as 2 years of age which was indicated on the Preschool Embedded Fiqures Test ,(a measurement of spatial visualization in children), (Bryden & Voyer &Voyer ,Meta-analysis of Sex Differences,1995). Also consistent with early testing of spatial ability were studies involving tasks of mental rotation in children as young as 4 by (Caldwell & Hall, 1970).No significant differences were found between gender on either of these tests, however ,the meta-analysis reviewed possibilities of floor effects occuring because children may have difficulty comphrehending what is required of them.Children tested between the ages 6 to 8 on mirror images, which involves mental visualization similar to mental rotations, show that children make a significant developmental leap between the ages of 6 to 8,(Cronin,1967). This study revealed the finding that ability to discriminate letter-like forms increases between the ages of 4 to 8. Troublesome discrimination for young children involves mirror -image reversal discriminations of "d" "b" and "p" "q". The study involved testing 144 kindergarden and 72 first-grades on mirror image reversals of triangles. It was found that first graders can discriminate more accurately and spontaneously than kindergarteners which suggests that first-grades regard orientation as an important dimension of difference. The results of this test on mirror images are consistent with the suggestion in the meta-analysis that other measures of spatial ability may produce a floor effect in children, due to requirement of a more advanced cognitive level.. The logic being, that as shown in the study by Cronin, that mirror-image reversal develops significantly between 6 and 8 and this test like mental rotations involves only mental visualization which lessens the likelihood of a floor effect in children .

The fact that children progress in development for the most part equally between gender until preadolescence and then differences of males outperforming females emerge rather quickly, is an area of psychology that still remains quite unclear. Gender differences favoring males increase from the ages 11 to 16 and are stable into adulthood,(Newcombe, Dubas & Judith,1995). Very few such findings are indicative of the childhood ages before preadolescence however, one of these rare studies was done in the age group 5 to 6 on a mental rotation task with results favoring males,(Cronin ,1967 as cited in Bryden ,Voyer & Voyer,1995).Also in the same task on a group of 10 year olds, males outperformed females ,(Tracy,1990 as cited in Bryden, Voyer & Voyer,1995). It is worth pointing out that major differences in spatial ability between gender favoring males in the preadolescent to adult range, have the largest effect sizes in tasks of mental rotations ,(Halpern,1992 ,Kirmura,1997 ;Richardson,1991). This is interesting, since mental rotations tasks only require mental visualization ,a simpler cognition, which would indicate that if there is a large difference favoring males on mental rotations in the preadolescent to adult range that a similar picture should be present in the childhood range .

Many factors are offered to account for differences between gender and why differences emerge when they do . The major influences lie along the lines of biology ,socialization and environment. Some theories of biological determinants presuppose a differentiation between gender, in brain structures from birth, that causes male superiority in spatial ability. One such study that hypothesizes that differences in male and female brain structures are due to the effects of prenatal hormones on the developing fetus was a study by,Kirmura, (1992). Studies done on girls exposed to excess levels of androgens during a critical period of development in the fetus,from a condition known as Congenital Adrenal Hyperplasia, (CAH) exhibited behavior of aggressive, non typical female type and had higher performance on spatial tasks. These girls had undergone surgical demasculinization,and appropriate gender hormone treatment. They were tested at the adolescent age and it was suggested that the effects of prenatal testosterone could not be reversed.

The assumption based on these indications was that increases in the androgens during a critical period had effected the brain structure,making these girls more male typed. Kirmura's theory for differences in brain stucture is supported by other studies. It is widely assumed by many researchers that the two hemispheres are more asymetrically organized for speech and spatial functions in men than women, (Halpern, 1997). Other studies have indicated that there are sex differences in the shape and volume of the corpus collosum, with females having more bulbous and larger structure, (Allen, Richey, Chai & Gorski, 1991).The architectural design in females is believed to give better connectivity between the hemispheres which is caused by prenatal hormones especially estrogens. Conversely the asymetrical design in males is speculated to give males a more distinct specialized area for some abilities such as spatial ability. The reason according to Kirmura for differences in spatial ability , favoring males, is due to better representation for spatial ability in male laterialized brain structure, caused by early effects of testosterone and other androgens. It was suggested that this effect only occured during a critical period in prenatal development.

If prenatal hormones cause differences between gender on spatial ability , we should see some initial difference between gender favoring males as early as possible. However, tests that require less advanced cognitive levels and involve single mental processes ,such as mirror reversal or mental rotations would likely be more sensitive to the childhood range.

Added to this biological vein are studies done on the ongoing effects of male and female sex hormones which are also indicated to effect the differences in spatial ability between gender.

In a study of normal aging men ,subjects were given hormone replacement therapy to improve sexual performance, the testosterone had an effect on increased spatial task performance, (Janowsky,Oviatt, & Orwol, 1994, as cited in Halpern, 1997). Also other research on the cognitive consequences of testosterone replacement therapies have shown that men who have low levels of the hormone improved their spatial performance, after testosterone supplemments were given . They had no such increases in areas where females typically excel, such as making up sentences and defining words,(Tannen,1992, as found in Halpern, 1997). Such findings point to possible reasons for larger differences in the postpurbertal age range , when laterialization is more complete and hormone levels are peaked for each sex and fits well with the theory of testosterone effects on the architecture of the brain . Indications are that gender differences in spatial ability seems to be consistent from puberty on through all ages,(Gittler, & Vitrouch, 1994).

If biological differences in brain structures have an influence on gender differences in spatial ability and pubertal and adult hormones do as well , then we should expect to see quite stable consistent differences in gender spatial ability in the younger ages until puberty,when differences in gender spatial ability are more significant.However at present not many differences between gender in the young age group for spatial ability, have been established. Possibly if testing a basic aspect such as mental rotations,where there are believed to be more increases recently, with males outperforming females, (Voyer, Voyer, & Bryden's Meta - analysis 1995), a difference between gender in spatial ability would be picked up,especially if current theories of biological influences are accurate.

Other theories that offer reasons for differences between gender favoring males, on spatial ability are environmental causes that, unlike biological influences , should have a gradual effect that occurs throughout all age levels. Environmental theories seem to offer a more plausible explaination for the fact that gender differences are seeminly less significant in the younger age group. Since gender differences are less significant in children, possibly a gradual increase in differences would be more subtle and therefore harder to detect.

In support of environmental factors, a study on a model of A X-Linked Recessive hypothesis to predict the mode of genetic inheritance of spatial ability was not supported, and lead to findings that indicated environmental factors Gittler, Vitrouch, (1994).The theoretical assumption of the X-Linked Resessive Gene is based on inheritance of good spatial ability from an X recessive gene and since men have only one X chromosome that can be passed on to their offspring, and women have two X's ,the ability for good spatial ability would have a higher occurance in the male population. When as usual the recessive gene is indicated by "a" and the dominant one by "A" males would have the ratio for good spatializers : X (a) or X(A) ("poor") , for 1/2 of the male population but coming from the women's genetic complement : X(A) X(A) ("poor"), X(A)X(a) ("poor"), X(a)X(a) ("good") which is formulated to mean only 1/4 of females are good spatializers. To test this hypothesis spatial testing between parental and sibling generations should show no correlations between father and son's spatial ability, since the father only transmits a Y chromosome to his son but never an X which comes from the mother . If this theory was supported it would leave out environmental influences, however no such correlations were found to support this theory , but rather an environmental influence was indicated by the results. On two spatial tests used, results showed that differences were found of males higher spatial ability over females in the parental generation but not in the filial generation. Also results showed that members of the filial generation scored significantly higher than the parental generation which may indicate educational factors or environmental ones. The assumption being that brothers and sisters attend to the same curricula and their similar performance could be due to similar education.

Another study that shows the influence of environment are brain imaging techniques that show the results of learning in the cortical representations of the brain , (Ungerleider,1995). He has advocated that what people learn affects brain structures, such as dendrite branching and cell size; brain design therefore supports certain skills and abilities,which may cause people to seek additional similar experiences. Brain imaging techniques had shown that when spatial activity is engaged in ,brain cell growth in certain areas occur. It seems that if a skill is acquired through learning that the person is more likely to engage in this type of activity , so that if males engage more in spatial activity than females they would become better at such skills. This is sort of a circular cause and effect cycle which may occur if males typically engage in spatial activity because of social roles they become better at these tasks, and also if they are biologically better they may engage in such activities more. Environmental processes such as learning should have a more subtle and gradual effect on any gender differences that may emerge in age groups up to preadolescence.

Another study along the lines of environmental factors was done on gender differences of spatial ability on adult populations of various educational levels,such as graduate and undergraduate and undergraduate,with mental rotation tasks ,(Richardson,1994).The results of this study confirmed prior research that this measure of spatial ability improves during study,specifically, gender differences were even eliminated in the group of highest educational level (graduate) .

Other theories that are similar to environmental ones are socializational ones and it seems reasonable that these theories either separate or together should cause gradual differences in spatial ability favoring males . If they do account for the gap between gender on spatial ability there should be also a gender difference in spatial ability in the age groups up to preadolescence as well as after. Currently research does not explain why no such significant differences have been found in the childhood range, but consistently found in preadolescent to adult groups.

One study that favors a socialization cause was done on two groups of males and females at prepuberty ,(age 11) and purberty levels,(age 16) to predict spatial activity and ability at purberty from a self selection survey . This was a longitudinal study on 477 subjects that used a questionaire to survey which traits male and female preadolescents viewed as either masculine or feminine .The subjects were asked which traits they found desirable and the traits were correlated with masculinity or feminity ; it was found that spatial ability was viewed as masculine. Females who didn't see this as desirable showed a low activity rate for spatial activity when surveyed again at puberty,(Newcombe,Dubas, 1992). Asessment was based on different aspects of personality namely, masculine intellectual interests of the ideal self,wanting to be a boy and femininity(particularly, emotional expressivity). One interpretation was that spatial ability is sex typed as masculine, and therefore women whose self concept is indicative of that label are more inclined to spend time on spatial tasks.The study found evidence for self selection of spatial activity based on spatial ability at age 16 . If socialization and environmental factors are valid reasons for gender differences in the 16 to adult group, as suggested by the later theories, than by way of the processes we should expect to see at least a gradual gender difference in spatial ability favoring males, since the sexes are exposed to environmental and socialization influences from day one of life.

SUMMARY

Testing for gender differences in a young broad age group seems to an area that hasn't fully been explored. Few studies have been done in this area in the past 13 years according to (Voyer, Voyer & Bryden, 1995), in a meta-analysis on sex differences in spatial abilities. Also testing spatial ability in young children may depend on how this development occurs, in view of the fact that different tasks require different levels of cognition. Mental rotations require only single mental processes such as mental visualization. Other measures of spatial ability such as spatial visualization and spatial perception require dual processes that demand more working memory than may be developed yet. The fact that multiple studies have found significant differences between gender on spatial ability favoring males with largest differences in mental rotations, in the preadolescent to adult age range, but not before preadolescent range may indicate that testing hasn't been sensitive to the childhood range.

Theories reviewed that offer reasons for gender differences in spatial ability favoring males don't give a clear picture as to why there is an absence of gender differences in spatial ability in children. If prenatal effects of hormones cause increased spatial ability in males than there should be some initial difference as early as testing is possible in children on a valid testing measure of spatial ability. As well if environment and socialization cause gender differences in spatial ability favoring males than we should see a gradual difference in the childhood range before adolescence on a sensitive test of childrens spatial ability. Also a cross sectional sample of children might reveal a picture of any developing differences on spatial ability between gender before preadolescence. In an attempt to explore this area of gender differences in spatial ability in children , I am asking the question "Is there a difference in in children"? I have hypothesised that using a basic measure of spatial ability , namely mental rotations on a cross sectional group of children, some gradual gender differences in spatial ability favoring males should occur due to the subtle effects of environment and socialization.

I have chosen three age groups : 6, 8, & 10 year olds consisting of male and female for a total of 158 subjects. A mental rotations test will be used ,since the task only requires one mental process (mental visualization), it will be appropriate for the cognitive level of the subjects and more sensitive to any developing gender differences in spatial ability. This will give a cross sectional sample of the period before preadolescence when research shows gender differences favoring males have started to emerge. I will use three versions of the test , one for each age group ,varying in complexity ,due to the different ages being tested. The mental rotations test will be modelled on a three dimensional one, (Sheppard & Metzler,1971). The test used will be a pencil and paper version done in grid form with different number of grids filled in ,producing different fiqures. The subject will be asked to find the fiqure on either side of the center stimuli that is a mental rotation of the fiqure and not the mirror image, which will also be shown on either side. The test instructions will be given verbally and pretest samples will be given . Results will be compared in terms of any gender differences in spatial ability scores and also between levels to give indications of concept development .

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Abstract

Multiple studies have found gender differences in spatial ability with males outperforming females. Most findings have been in the preadolescent to adult range, with few significant findings in children. A recent meta-analysis has suggested that gender differences in spatial ability probably exist in children but haven't been detected, due to children having a less advanced cognitive level than adults. A pencil and paper test of mental rotations was given to 6, 8, & 10 year old children to give a cross sectional sample of any developing gender differences in spatial ability. There were no significant gender differences in spatial ability, but there were significant differences between the age groups, demonstrating that spatial ability does increase with age.

Introduction

There has been a lot of research into gender differences in spatial ability, with males outperforming females. Most significant differences have been found in the age groups 11 to 16 and stabilizing into adulthood, (Newcombe & Dubas, 1996). Studies on the younger groups before preadolescence, have been less extensive, and more restrictive in the age range per study, with fewer significant findings of differences between gender. The question arises: why are such differences exhibited in older groups but not nearly to the same degree in younger age groups?

Spatial ability is not a unitary concept and also develops with age and processing level of mental ability, (Voyer , Voyer & Bryden,1995). Spatial ability is categorized by three aspects: spatial perception, spatial visualization and mental rotations. Mental rotation only requires mental visualization whereas, spatial visualization and spatial perception tasks require dual processes and a larger working memory than may yet be developed in children. This may cause complications in testing the ages before pre-adolescence since, many of the standardized tests used for children consist of tasks requiring component processes. For example, in "The Wechsler Preschool and Primary Scale of Intelligence" test, performance on a block design test and a geometric design for visual -spatial perception the child is requested to replicate designs which requires increasing the amount of short term memory as well as using mental visualization.

Children have been tested as young as 2 years of age which was indicated on the Preschool Embedded Fiqures Test,(Reppussi, 1971), a measurement of spatial visualization in children,(Voyer, Voyer & Bryden, 1995).However no significant differences were found between gender. Also consistent with early testing on spatial ability were tasks of mental rotation in children as young as 4, (Caldwell & Hall,1970). No significant differences were found between gender on this study either and it was suggested by Voyer , Voyer & Bryden, 1995 in a meta-analysis that a possible floor effect occurred due to children having difficulty knowing what was required of them.

On a test of mirror images which involves only spatial visualization similar to mental rotations children were able by 8 years of age to make a significant leap in grasping the concept, (Caldwell & Hall, 1970). This study involved 144 kindergardeners and 72 first -grades who were tested on a mirror image test.It was found that first grades can discriminate more accurately and spontaneously than kindergardeners. This is consistent with suggestions by Voyer, Voyer & Bryden that some measures of spatial ability like spatial visualization and spatial perception require more complex cognition than is developed in young children, creating a floor effect.

Clearly children can comphrehend mental rotations easier than other tasks and research previously done does not show significant differences between gender on spatial ability in children. It is therefore quite interesting that most significant gender differences in spatial ability favoring males have been found in the preadolescent-adult range, with the largest differences on mental rotations tasks, over other measures of spatial ability, (Voyer, Voyer & Bryden, 1995). This seems to indicate that if large differences in spatial ability favoring males are in the mental rotations task than at least some difference should emerge in the before pre-adolescent range. Mental rotation is shown to be a task using only mental visualization ,the same mental process as the previous one done on mirror images ,indicating that this measure of spatial ability should be sensitive enough to pick up any differences in children.

Many theories give explainations of why gender differences favoring males emerge at all ,they include biological , socialization and environmental factors. There doesn't seem to be agreement by researchers at present as to why differences in spatial ability favoring males only occur in the pre-adolescent to adult range .Each theory however, offers some valid insight into the influencial factors.

When looking at theories for gender differences in spatial ability we find those favoring a biological theory that state that male and female brain structures differ due to the affects of prenatal hormones on the developing fetus. The male hormone androgen appears to cause differences in male and female brain structures during a critical time in development, (Kirmura,1992). The lifelong effects of early exposure to sex hormones are characterized as organizational in that the architecture of the brain is mapped out differently for each sex. Sex hormones were said to achieve the transformation of the genitals into male organs, as well as affect corresponding behavior very early in life. Kirmura found through studies done by a collegue, (Resnick,1995) that hypothesised that differences in male and female brain structures are due to the effects of prenatal hormones on the developing fetus. Studies done on girls exposed to excess levels of androgens (male Hormones), during a critical period of development in the fetus, had a condition known as Congenital Adrenal Hyperplasia, (CAH). These girls exhibited nontypical male behavior and also performed better than their female counterparts on spatial tasks. The girls had undergone demasculinization early in life and be given the appropriate hormone injections. The assumption based on these indications were that increases in the androgens during a critical period had effected brain structure, making these girls more male typed and better in spatial ability due to architectural changes in the brain.

Other support for differences in brain structures comes from(Allen, Richey, Chaao & Gorski 1991) that show there are sex differences in the shape, and probably the volume of the corpus callosum, with females in general having a larger and more bulbous structure.This finding supports the theory that female brains are more bilaterally organized in their representation of cognitive functions. . These types of biological theories imply that differences are there at a very early age, owing to the prenatal differences in brain structures. If the significant differences found in the older age groups of preadolescent to adult levels are the result of prenatal effects of hormones, then there should be some initial difference between gender favoring males on a simple measure of spatial ability .

Also to add another aspect of biological influence studies found that ongoing effects of male hormones were believed to play an important role in lifelong development of spatial ability in favor of males.In a study where normal aging men were given testosterone to improve sexual functioning, they also showed better performance on visual-spatial tests, (Janowsky, Oviatt, & Orwol, 1994,as cited in Halpern, 1997). Other research on the cognitive consequences of testosterone replacement therapies has shown that men who have low levels of the hormone improved their spatial performance but no such improvement was found in areas where females typically excel, such as making up sentences and defining words, (Tannen,1992, as found in Halpern, 1997). Such findings point to possible reasons for larger differences in the postpubertal age range,when laterialization is probably more complete and hormone levels are peaking for each sex.Indications are that gender differences in spatial ability seem to be consistent from puberty on through all ages,(Gittler& Vitouch,1994).

Also environmental theories offer a plausible explaination for gender differences in spatial ability that are not highly signficant until prepurberty, since environmental effects would be less immediate than initial differences in brain structure. In a theory to predict genetic inheritance of spatial ability performance was tested using two different spatial tests.The theory being tested was based on a model of A X-linked recessive gene that would be reflected by more females than males being lower achievers in spatial tasks, Gitter & Vitouch. (1994). The empirical correlations from the sample did not support the model of a recessive gene. Subjects included male and female parents and adult siblings . However the fact that differences were found of males higher spatial ability existing in the parental generation but not in the filial generation pointed to the importance of environmental factors. Also results showed that members of the filial generation scored significantly higher than the parental generation which may indicate educational or environmental factors. The assumption was that brothers and sisters attending to similar curricula may have similar performance due to similar education.

Another study in favor of an environmental influence was done using brain imaging techniques indicates that changes in cortical representations are observed after specific experiences, (Ungerleider, 1995 as cited in Halpern, 1997). Ungerleider advocated that what people learn affects brain structures, such as dendrite branching and cell size: brain design, therfore supports certain skills and abilities, which likely lead people to seek additional similar experiences in sort of a circle of cause and effect. It appears to be a circular cycle in that if a person is naturally good at this activity ,they will be more likely to engage in spatial activity, which if they practice more brain cell increases will occur,giving them increases in spatial ability.

Other theories similar to environmental factors ,are socialization ones, in that effects due to this influence should also cause subtle gradual changes in male superiority for spatial ability, that should develop gradually before adolescence.One such study that favors a socialization cause was done on two groups of males and females a prepuberty,(age 11) and purberty levels,(age 16) to predict spatial activity and ability at purberty from a self selection survey. This was a longitudinal study on 477 subjects that used a questionaire to survey which traits male and female preadolescents viewed as either masculine or feminine. The subjects were asked which traits they found desirable and the traits were correlated with masculinity or feminity; it was found that spatial ability was viewed as masculine. Females who didn't see this as a desirable trait, showed a low activity rate for spatial activity when surveyed again at puberty, (Newcombe, Dubas,1992). Assessment was based on different aspects of personality namely , masculine intellectual interests of the ideal self, wanting to be a boy and wanting to be a girl and femininity (particularly , emotional expressivity), the study found evidence for self selection of spatial activity based on spatial ability at age 16. If socialization and environmental factors are valid reasons for gender differences in the 16 to adult group, than by way of the processes we should expect to see a gradual gender differences in spatial ability favoring males, since the sexes are exposed to environmental and socialization influences from day one.

At present there does not seem to be adequate understanding of why gender differences in spatial ability favoring males are predominantly significant in the preadolescent -adult range but not consistently found in the before preadolescent range. Due to the difference in cognitive ability children have been tested on spatial tasks that were likely not sensitive to their ability creating unfair comparisons between ages and gender. A test on mental rotations, that is a pure simple measure of spatial ability with a cross sectional approach to the different childhood levels would be helpful in trying to understand this gap between gender that doen not appear to be adequately explained.

I have hypothesised that in the before pre-adolescent period,(using a mental rotations test as a measure of spatial ability) a gradual difference in spatial ability favoring males should be detected . Due to the subtle, gradual process of socialization and environment, an effect of male spatial superiorty that has been so represented in pre-adolescent to adult age, should show an accumulative effect. So I am asking the question Is There a Difference Between Gender on Spatial Ability In Children?

Method

I selected 159 subjects from the public school ,consisting of 74 females and 85 males.Subjects were from three age groups : 6, 8, & 10 year olds.

Apparatus

The only apparatus used was a paper and pencil version of a mental rotations test, based on Shephard & Metzler (1971) three dimensional design. Three levels of the test was used , one for each of the three age groups . There were 27 test items, each question consisted of figures done in grid form, the center stimuli was the figure they were to match with the one on either side that was a mental rotation of the stimuli. The other figure in the test question was a mirror image of the center stimuli. Level one of the mental rotation test I designed was a 3 by 3 blocked grid ,level two was a 4 by 4 design and level three was a 5 by 5 design.The test were graduated in complexity by number of grids filled in and symetry of design between levels due to the fact that different aged children have different cognitive levels.

Procedure

I tested the subjects in their home room which was free of other activity. They were given three samples of test items to do with verbal instructions and any questions regarding how to answer them were explained. The subjects were asked to circle the item on either side of the center figure that looked as though the center figure was turned (mental rotation) and not the other figure which looked as though the center figure was backward (mirror image) . Subjects were given 15 minutes of instruction including time to answer the three samples. Than they were given the test of 27 items and told they had 30 minutes to complete it. Subjects were asked to put either m for male or f for female on the top .

Results

Three schools were selected for 3 age groups each, however level 2 dropped out of the study,from one school ,so another level 2 was picked up from another school . No analysis was done for between school effects.There were no significant differences found between gender, however it approached significance for females at p=.08 and an F=8.20 ,with F critical=3.85. The mean for gender was females 23.703 and males 21.576. There were signficant differences between levels with calculated F=8.20 and F critical = 3.05, at a p=.ooo which shows a high probability that there were significant differences between age. The mean for level 1 was 18.08, for level 2 was 23.60 and for level 3 was 24.22, showing a jump between levels 1 to 2 for ages 6 to 8. In view of the fact that the levels were increased in complexity the F value could be actually higher, since level 2 and 3 were more difficult than level one.

Discussion

The results of no significant differences between gender on mental rotations favoring males does not support the hypothesis that gradual differences favoring males would be present in the age groups before pre-adolescence. It was close to being the opposite, with females approaching significance for gender differences in mental rotations. A theory on prenatal effects of hormones on brain structure is not consistent with the results, which should have shown some initial difference quite early favoring males. The prenatal effects of hormones were indicated in Kirmura's (1995) ,study to cause increased spatial ability in males. Also studies done that indicate largest differences in spatial ability favoring males are on mental rotations ,(Halpern, 1995; Kirmura, 1997; Richardson, 1991) is not reflected at all in this cross sectional sample. The fact that mental rotations is a simple process of mental visualization that doesn't require complex cognition makes the results of this study especially inconsistent with current theories of cause for gender differences in spatial ability favoring males. Theories that support an evironmental or socialization cause still do not explain why no significant differences were found in children .These type of influences are present from day one of life and should show some gradual effect in children if they account for male superiority in spatial ability in the pre-adolescent to adult range.

It may be more likely that an accumulation of environmental ,socialization ,prenatal and life long hormones interact to give the pattern of differences in gender spatial ability that we currently know. The fact that differences only significantly start to emerge at pre-adolescence, possibly indicate testosterone levels increase as puberty approaches, in an additive manner with environmental and socialization factors to cause consistent gender differences in spatial ability that remain quite stable.

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