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A NEW FRAMEWORK FOR INVESTIGATING COGNITIVE SEX
DIFFERENCES

A Thesis
Presented to the
Faculty of
California State University,
San Bernardino

In Partial Fulfillment
of the Requirements for the Degree
Master of Arts
in
Psychology

by Tiffany Marie Wright

December 1993

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Approved by:


Diane Halpern, Chair, Psychology

12/3/93
Date



Geraldine Stahly

ABSTRACT

Cognitive sex differences have been traditionally differentiated by cognitive abilities. Previous researchers have concluded that males perform better, on average, than females on visual-spatial tasks and quantitative tasks, while females show superior performance at verbal tasks. However, the tri-part abilities rubric does not explain some glaring inconsistencies. Males are better at some verbal tasks (e.g., verbal analogies) and females are better at certain quantitative tasks (e.g., arithmetic). In order to explain these anomalies, Halpern (1992) suggested that a more useful model of cognitive sex differences would differentiate according to the underlying mental processes. This study found considerable support for the hypothesis that females would show superior performance on tasks that require rapid access to and retrieval of information from memory and males would show superior performance on tasks that require maintaining and manipulating a mental representation. The results suggest that it would prove beneficial to investigate what we can learn by examining the nature of sex differences according to the mental processes involved. It is concluded that categorizing sex differences according to the underlying cognitive processes would not

only explain the anomalies but will prove to be a more meaningful means of investigating sex differences.

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It is true that I am not known for my verbose vernacular, and therefore, with little effort, this section will be short, but sincere and sweet. I thank Dr. Robert Cramer. Dr. Geraldine Stahly and the participants in this experiment. Most expecially I would like to thank Dr. Diane Halpern for her exceptional teaching skills, unbelievable source of information and uncompromising professionalism.

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INTRODUCTION

How and in what ways are men and women different? The answer to the question is sought after by psychologists, biologists, sociologists, anthropologists and the nation as a whole--all intently interested in how, how much, and when women and men differ. However, it is important to note as the sex-differences war rages on, stereotypes concerning the differences between the sexes are always more drastic than the observed differences (Wittig and Peterson, 1979). These stereotypes include girls being more social, verbal, suggestible, compassionate and less physical, while boys are more achievement motivated, better at math, more courageous and more aggressive. While there is little empirical evidence to support these stereotypical beliefs, factor analyses have shown that there are at least three different intellectual abilities that most frequently show sex differences, these include verbal ability, quantitative ability and spatial abilities (Halpern, 1992). These findings suggest that there are three separate factors, and therefore, three independent abilities. The aim of this study is to investigate the utility of differentiating cognitive sex differences on the basis of the type of cognitive process that individuals use across a variety of cognitive tasks instead of the traditional tri-part

abilities rubric (verbal, quantitative, visual-spatial). Because there is little background in this type of analysis, it is useful to look at the way sex differences research has traditionally been conceptualized, through cognitive abilities, and point out why and where it is inadequate, and to suggest an alternative classification system that may prove more useful.

Psychologists, who study cognition, have the blessing of working with some of the most robust findings in all of psychological research. There seems, by virtue of the way it is measured, to be no sex differences in overall intelligence (Halpern, 1992; Maccoby and Jacklin, 1974). However, there are three abilities in which sex differences have been reliably found and replicated. On average, men score higher than women on some tests of quantitative and visual-spatial abilities, and women score higher than men on some tests of verbal abilities (Halpern, 1992; Hyde, 1990; Hyde, Femmema, Lamon, 1990; Kimura, 1992; Lips & Colwill, 1978; Maccoby & Jacklin, 1974; Ruble, 1988; Sherman, 1978; Wittig & Petersen 1979). Hyde (1990) calculated an effect size, "d," for the studies collected by Maccoby and Jacklin and found, $d = -.24$ for sex differences in verbal ability, .45 for spatial ability and .43 for mathematical ability and more recently, Masters and Soares (1993) computed the effect

size on mental rotation to be $d=.90$. These findings are large and consistent enough to have important practical consequences.

Because of the consistency or size of the findings, some researchers have asked: Why continue to study sex differences (Hyde, 1981; Linn & Petersen, 1986)? In response to this question, Halpern (1992) cites a study by Backman investigating the relationship between sex, ethnicity, SES and their influence on mental abilities. Backman found that sex accounted for 69% of the total variance, with ethnicity and SES accounting for 9% and 1%, respectively. Clearly, gender has practical significance. The Binomial Effect Size Display (BESD), a statistical test developed by Rosenthal and Rubin (1982), also illustrates how a small percentage of the variance can have important implications. For example, when measuring the success of treating cancer patients, a correlation of only .20, translates into an increase of the cure rate from 40% to 60%. The implication of the BESD to cognitive performance can have important implications when predicting performance on ability tests (Halpern, 1992), as well as possible practical implications for job selection (Burnett, 1986).

As stated above, when examining sex differences, psychologists have traditionally analyzed sex differences

for cognitive abilities. What are verbal abilities, visual-spatial abilities and quantitative abilities? These abilities are constructs that the people using them believe they are measuring when they administer certain tests. Cognitive abilities are constructs that represent the underlying components of intelligence (Halpern, 1992). Below, I will discuss, each of the three abilities (verbal, visual-spatial and quantitative) and the evidence for sex differences.

Verbal Abilities

Although the effect size is the smallest and the most inconsistent of the three abilities discussed in this paper, there is a strong consensus that there are sex differences in verbal ability favoring females (Halpern, 1992; Lips & Colwill, 1978; Maccoby & Jacklin, 1974; McGuinness, 1976; Sherman, 1978). There is much disagreement and inconsistency in the literature concerning at what age the sex differences in verbal abilities emerge and how large the differences are. Hyde and Linn (1988) concluded that females tend to show superiority on verbal tasks as early as the age of five, and while there is some disagreement as to when the advantage begins, the advantage is maintained into adulthood (Halpern, 1992; Lips & Colwill, 1978).

Perhaps the disagreement and inconsistency about the effect size of sex differences in verbal ability is due to indiscriminate classification of which verbal tasks measure verbal ability. Verbal ability encompasses a wide variety of tasks. Word fluency, grammar, spelling, reading, verbal analogies, vocabulary, word naming, language production, generating synonyms, vocabulary recognition and oral comprehension could all be categorized as tasks that measure verbal ability (Halpern, 1992; Lips & Colwill, 1978). Halpern (1992) delineates the verbal tasks at which women perform superior to men. These tasks are: language production, generating synonyms, word fluency and anagrams. Notice the anomaly. Men excel at verbal analogies (Hyde & Linn, 1988). This distinction will be dealt with later in this paper.

Quantitative Abilities

Sex differences in quantitative abilities are much larger than those found in verbal tasks, and for many, but not all, they favor males (Halpern, 1992; Hyde, Fennema & Lamon, 1990; Lips & Colwill, 1978; Maccoby & Jacklin, 1974; McGuinness, 1976; Wittig & Petersen, 1979). The male advantage begins around 13 years of age and continues into adulthood (Halpern, 1992; Hyde, Fennema & Lamon, 1990). This is due to both an increase in male aptitude, possible

because of, more math classes, greater interest or some other variable, as yet unidentified, and also, to a curious decrease in girls' tested mathematical ability between ages 11-15 with respect to prior performance (Ross & Simpson, 1971). Based on studies testing thousands of subjects and considering more than 200 effect sizes, Hyde, Fennema & Lemon (1990) found the mean magnitude of sex differences in mathematics performance to be 0.20. However, it important to remember that this value mixes large and small effects.

Just as with verbal tests, there is considerable variability in what constitutes "quantitative ability." Mathematics includes a variety of tasks which vary in the skills needed for successful performance. Computation, problem solving, geometry, algebra, trigonometry and calculus are all quantitative tasks and there are sex differences among them. Regarding the variability in quantitative ability, Halpern (1992) cites a very germane study by Stones, Beckman and Stephans (1982). They found that when college students at ten different colleges were given tests in ten different mathematical categories, there were sex differences found on individual tests. There were, however, no significant overall sex differences. Hyde, Fennema and Lamon (1990) found that when averaging over all studies, there was a slight female advantage in performance

in elementary and middle school years, with this advantage disappearing by high school. Marshall and Smith (1987) found an girls exhibit an advantage in third grade, which disappears by sixth grade. The female advantage in their younger years appears to be due to the type of task involved, with female superiority in computation tasks (Halpern, 1992; Chipman, Marshall & Scott, 1991; Hyde, Fennema & Lamon, 1990), a task utilized more in the earlier school years. Again, note the anomaly. Males have better quantitative abilities than females, with the exception of computation. The female advantage on some mathematical tasks and male advantage on others obviously deflates the overall effect size and may obscure some important differences among types of mathematical problems.

Visual-Spatial Abilities

By far, the largest cognitive sex difference is found in visual-spatial ability. The male advantage in spatial ability is well documented and has been recognized for decades (Halpern, 1992; Hines, 1990; Hyde, 1990; Hiner, Chiu, McAdams, Bentler & Lipcamon, 1992; Johnson & Meade, 1987; Linn & Petersen, 1985; Maccoby & Jacklin, 1974; McGuinness, 1976).

In an early analysis of the sex differences literature, Maccoby and Jacklin (1974) concluded that large sex

differences in visual-spatial tasks, favoring males, appear around adolescence and continue into adulthood. However, more recent analysis such as Johnson and Meade (1987) found a male advantage in certain spatial tasks at fourth grade.

The construct of visual-spatial ability does not have a clear unitary definition, in part because it is not a unitary concept (Nyborg, 1988). Spatial perception, mental rotation and spatial visualization are all factors that have emerged as being visual-spatial abilities (Linn & Petersen, 1986). Halpern (1992) states that visual-spatial abilities refer to "the ability to imagine what an irregular figure would look like if it were rotated in space or the ability to discern the relationship among shapes and objects" (p.68).

Visual-spatial abilities can be measured by mental rotation, hidden figures, water level tests, paper folding, road maps and other tasks. However, Linn and Petersen (1985) proposed three categories as a way of organizing these different tasks, "spatial perception", "mental rotation", and "spatial visualization." Briefly, spatial perception requires subjects to locate the horizontal or vertical while ignoring distracting information. Mental rotation involves the ability to accurately rotate a two- or three-dimensional figure. Finally, spatial visualization

requires complex analytic processing of spatially presented information. These three categories are important when analyzing visual-spatial ability because sex differences appear differentially according to the category being measured (Halpern, 1992; Hines, 1990; Schiff & Oldak, 1990; Linn & Petersen, 1985; Linn & Petersen, 1986).

According to Linn and Petersen (1986), sex differences occur on two of the three categories, spatial perception and mental rotation, both favoring males; the effect size for spatial perception $d=.64$, mental rotation $d=.94$. Besides the traditional static spatial reasoning tasks listed above, recent research suggests that males show superior performance at dynamic spatial reasoning tasks, such as judging the relative velocity of moving objects (Law, Pellegrino & Hunt, 1993).

The usual conclusion is that males perform better at quantitative tasks and visual-spatial tasks and females perform better at verbal tasks. However, this literature review has shown that the traditional tri-part rubric (verbal, quantitative, visual-spatial) is not adequate. This classic distinction based on examining sex differences for cognitive abilities does not explain why females perform better than males on some quantitative tasks, such as computation, and males perform better than females on some

verbal tasks, such as verbal analogies. The cognitive abilities interpretation also fails to explain why males score so much better on some visual-spatial tasks (mental rotation), while no sex differences are shown on other visual-spatial tasks (spatial-visualization). Nor does the "abilities" differentiation explain the finding that females show more variability of test scores on some visual-spatial tasks, while males show more variability of scores on other visual-spatial tasks (Halpern, 1992).

If examining sex differences for cognitive abilities does not tell us how females and males differ in their intellectual processes, what can? Halpern (1992) suggests a more process oriented approach. Perhaps it may be advantageous to differentiate cognitive tasks on the basis of the type of cognitive process that each requires. The tasks at which females perform better include language production, generating synonyms, word fluency, anagrams, and simple arithmetic. All of these tasks require rapid access to and retrieval of information that is stored in memory (Halpern, 1992). In support of this hypothesis, McGuinness (1974) cites several studies that show females were superior in delayed recall, in short-term processing as well as recall for both visual and verbal information, and that

females were faster in simple reaction time tests than males.

Males, on the other hand, perform better at mathematical problem solving, verbal analogies, mental rotation, spatial perception, and using information in dynamic visual displays. These tasks all require the ability to maintain and manipulate mental representations (Halpern, 1992; Linn & Petersen, 1986). The premise that males have superior ability at tasks that require the ability to maintain and manipulate mental representations fits nicely with McGuinness (1976), where she cites several studies that show males respond preferentially to blinking lights, geometric patterns, colored photographs of objects, and three-dimensional objects. A more process oriented approach might not only deal with the inconsistencies listed above, but might lead to a new understanding of the nature of sex differences.

STATEMENT OF PROBLEM

The hypotheses of this investigation are 1) males will outperform females on the tasks that require maintenance and manipulation in short term memory-- mental rotation and verbal analogies, and 2) females will outperform males on tasks which require access and retrieval of information from stored memory-- word fluency, arithmetic and synonym

generation. This is the first study in which all of these different tasks have been employed with the same group of subjects.

This study employed five tasks that differed in terms of the nature of the underlying cognitive process that each required. An arithmetic task and synonym and letter fluency generation task was used, all of which require access and retrieval of information from stored memory. In addition, a mental rotation task and verbal analogy task were used, both of which require maintenance and manipulation of mental representations.

METHOD

Subjects

There were 78 female and 72 male participants whose mean age was 29.21 years ($sd=8.56$, minimum age 18 years and maximum age 54 years). Subjects were undergraduate and graduate students from California State University San Bernardino. The subjects received class credit for their participation, where appropriate. All subjects completed a questionnaire and perform all the tasks.

Materials

For the synonym generation task and word fluency task subjects generated synonyms for a list of common words and as many words as possible for a list of letters. The

answers were recorded by a standard tape recorder. The mental rotation task, arithmetic task and verbal analogy task, were presented on Micro Experimental Lab (MEL), a computer software program that regulated presentation time and records reaction time. The computer used was an IBM with a color monitor.

MEASURES AND PROCEDURES

Arithmetic Task

The arithmetic task was a self paced presentation on MEL. Subjects had four practice simple arithmetic problems then continued on to the experiment when they were ready. There were forty problems, which included simple addition, subtraction, division and multiplication. The subject responded to a simple problems in which the answer given was either true or false, for example, $2+3=6$. Subjects did not receive feedback about their accuracy or reaction times. Reaction times and number correct were collected.

Verbal Analogies Task

The verbal analogies task was a self paced presentation on MEL. Subjects had four practice problems followed by twenty-four experimental problems. The verbal analogies task consisted of a two-part presentation for each analogy. First, the analogy stem was provided (X:Y as A:?) with the first reaction time a measure of how long the stem portion

was left on the monitor. The subject indicated when ready to proceed with a key press which terminated the first reaction time. The second reaction time began with a key press and ended when subjects indicated their response with a second key press. For the second reaction time period, subjects saw the analogy stem along with the possible answers and they pressed a button corresponding to the correct answer. Thus, two reaction times and number correct were collected for each analogy, for each subject. The analogies can be found in Appendix A.

Mental Rotation Task

The mental rotation task was a self-paced presentation on MEL. Subject pressed the appropriate key when ready to begin. Subjects were given four practice problems and twenty experimental problems. Reaction times begun as soon as two geometric figures were shown on the screen. The subject's task was to determine whether they were the same objects except for there orientation. The subject choose true or false.

Synonym and Letter Generation Fluency Task

The synonym and letter generation fluency tasks were given by the experimenter and the responses to this task were tape recorded. In the letter fluency task, subjects were given a letter (r, l, m, p, r, a and s) and one minute

to generate as many words that begin with the letter given. Subject were given practice problems to familiarize them with the task. The number of words beginning with the given letter was tallied. Subjects were given a list of common words (strong, happy, turn, pretty, sharp, dark, wild and tell) and had one minute to generate as many synonyms, for each word, as possible. Two raters determined whether the answers were "correct" synonyms. The number of synonyms for each word was tallied.

RESULTS

Mean number correct and reaction times were calculated by sex for each of the five cognitive tests (simple arithmetic, verbal analogy, mental rotation and synonym generation and letter fluency). Results are presented separately for each task.

Arithmetic

Two different dependent measures were used to measure sex differences in simple arithmetic tasks. The total number correct was tallied for each individual and the mean reaction time was calculated beginning with presentation of problem and ending with the selection of a true or false answer. Unexpectedly, there was a significant difference by sex, favoring males, when the performance on arithmetic problems was evaluated by simply counting the number of

problems answered correctly $t(148) = -1.79$, $p = .0375$: females (mean=37.25, sd=2.07); males (mean=37.82, sd=1.74); $d = .30$. There was also no significant difference in the reaction times of the females and males when performing the arithmetic task $t(148) = .88$, $p = .379$: females (mean=2587.33 ms., sd=625.87 ms.); males (mean=2495.35 ms., sd=651.25 ms.).

Verbal Analogy

Three dependent measures were calculated to investigate sex differences in verbal analogies: number of analogies correct and two reaction times--study time and response selection time. As hypothesized, males had significantly more verbal analogies correct than females $t(148) = -1.99$, $p = .0245$: females (mean = 14.83, sd = 3.51); males (mean = 15.93, sd=3.22); $d = .33$. Males did not have significantly faster "response selection" reaction times $t(148) = -.90$, $p = .184$: females (mean = 3151.29 ms., sd=1288.940 ms.); males (mean = 3344.20 ms., sd = 1325.62 ms.). However, as expected, males did have significantly faster "study" reaction times $t(148)=2.01$, $p = .0235$: females (mean = 3655.31 ms., sd = 1428.78 ms.); males (mean = 3200.00 ms., sd = 1344.02 ms.); $d = .33$.

Mental Rotation

Sex differences on the mental rotation task were measured by the number of correct responses to the mental rotation problems, the overall mean reaction time and mean reaction time at each degree of rotation. As expected there was a significant difference, favoring males, in the number of rotation problems answered correctly, $t(148) = -2.17$, $p = .016$: females (mean = 4.36, sd = 4.99); males (mean = 6.11, sd = 4.91); $d = .35$. Surprisingly, however, there was no significant difference found between males and females on overall mean reaction time, computed by summing reaction time from each stimulus, $t(148) = .53$, $p = .30$: females (mean = 6500.65 ms., sd = 2019.40 ms.); males (mean = 6315.94 ms., sd = 2259.19 ms.). See table 1 for the individual reaction times for the varying degrees. Significance differences in reaction time favoring males were found only when the stimulus were the same and for degrees of rotation 0, 40, 80, and 120.

Synonym and Letter Generation Fluency

In the synonym generation task, subjects responded to eight common words (strong, happy, turn, pretty, sharp, dark, wild and tell) with as many synonyms as possible within a one minute period. The mean number generated in a

Table 1

Means and Standard Deviations for Reaction Times
from the Mental Rotation Task.

| DEGREE OF ROTATION | Females | | Males | |
|-----------------------|----------|-----------|----------|-----------|
| | <u>M</u> | <u>SD</u> | <u>M</u> | <u>SD</u> |
| SAME0* | 8590.5 | 4902.3 | 6882.6 | 4053.5 |
| SAME40* | 11164.3 | 4590.5 | 9574.5 | 4766.9 |
| SAME80* | 12579.1 | 4660.2 | 11027.8 | 4927.9 |
| SAME120* | 13977.4 | 6083.2 | 12424.1 | 5522.0 |
| SAME160 | 13735.4 | 6624.3 | 14448.0 | 6825.3 |
| DIF0 | 13633.6 | 5754.7 | 13627.5 | 6496.0 |
| DIF40 | 14217.2 | 5824.3 | 14180.0 | 5793.5 |
| DIF80 | 14432.4 | 6122.7 | 14973.5 | 6234.4 |
| DIF120 | 14806.3 | 5893.8 | 15506.9 | 8024.9 |
| DIF160 | 12876.6 | 6072.3 | 13673.7 | 7631.4 |

*Males responded significantly faster on these rotation stimuli, $p = .05$.

one minute period was 4.84 for females, and was 4.05 for males.

In the letter fluency task, subjects were given six different letters (r, l, m, p, a and s) and responded with as many words beginning with each letter as possible within a one minute period. The mean number generated for females was 15.41 and 14.34 for males.

Females provided more synonyms for each common word and more words beginning with the designated letters on every one of these fourteen tasks, six letters and eight words. This is a statistically significant difference ($p = .0001$) as assessed with a binomial test.

DISCUSSION

The hypotheses investigated in this study were 1) males would outperform females on the tasks that require maintenance and manipulation of information in short term memory--mental rotation and verbal analogies, and 2) females would outperform males on tasks which require access and retrieval of information from stored memory--synonym and letter generation fluency and simple arithmetic. And as expected, there were significant differences found between the females and male subjects on four of the five different cognitive tasks employed in this examination. Females performed better on every one of the fourteen synonym and

letter generation problems. Males, on the other hand, had more mental rotation and verbal analogy problems correct, as well as having a faster "study" reaction time on the verbal analogies. In addition, men had significantly more arithmetic problems correct. Surprisingly, however, the reaction time measures (while all in the predicted direction) were not significant for mental rotation (overall), simple arithmetic or the "response selection" time. I believe this to be due to the nature of the procedures used in the experiment. The computer was programmed to repeat all problems that were incorrect and only record the reaction time of the problem once it was answered correctly. I suspect that because there was 1) such a high error rate in mental rotation and 2) a significant difference in error rates for simple arithmetic the reaction time data are not completely reliable.

While sex differences in verbal ability, spatial ability and math ability have all been investigated extensively, the results found in this study are important considering the same subjects were tested on all three ability measures. The use of the same subjects tested on a variety of tasks and abilities who scored, by sex, higher on some tasks and lower on others lends strong support to the hypothesis that females and males use different underlying

cognitive processes. Using the same subjects, males outperformed females on the tasks that required maintenance and manipulation of information in short term memory, and females outperformed males on the tasks which required access and retrieval of information from stored memory. The only exception was in simple arithmetic. Thus providing sufficient preliminary evidence that categorizing sex differences according to the underlying cognitive processes would explain the consistent anomalies in the sex differences literature.

More importantly, a more thorough understanding of the cognitive differences between the sexes will make possible a narrowing of the abilities gap between males and females, perhaps providing a more equitable existence. For example, grouping sex differences by the underlying cognitive process involved will begin the process of eliminating the stereotypes that males are better at math activities and girls are superior at verbal activities--they simply use different strategies at solving the problems. In addition, finding the locus of these differences and the fundamentals of these processing strategies will enable educators to teach children how to use both strategies with competence, and when to apply the appropriate strategy to different problems. For example, it is quite possible that males

outperform females on verbal analogies because verbal analogies require a different strategy than most verbal tasks--i.e. maintenance and manipulation of information in memory. Subsequently, males are using the strategy they know best and getting superior scores. While females are using a different strategy, that normally works well with verbal tasks, but is in fact, less effective for verbal analogies. But, only when an understanding of the processing strategies can be comprehended will we be able to teach and encourage children to develop both processes and use them effectively.

The results of this study are not surprising. The cognitive abilities literature abound with the same results and the same anomalies. It is time to cease the grouping of sex differences by cognitive abilities and begin to categorization sex differences according to the underlying cognitive processes involved. A change in this direction will undoubtedly prove to be a more precise and fruitful means of investigating sex differences.

APPENDIX A

Verbal Analogies

1. NECKLACE : BEAD :: CHAIN :
A. GOLD B. LINK C. LOCKET
2. MOUNTAIN : PEAK :: WAVE :
A. RIPPLE B. CREST C. OCEAN
3. WEIGHT : POUND :: DISTANCE :
A. FAR B. MILE C. ACRE
4. AUTOMOBILE : CHARIOT :: CLOCK :
A. WATCH B. HOUR C. SUNDIAL
5. TEMPERATURE : THERMOMETER :: TIME :
A. CLOCK B. MINUTES C. SUN
6. CORK : LIGHT :: LEAD :
A. HEAVY B. SINK C. WEIGHT
7. SPHERE : CIRCLE :: CUBE :
A. TRIANGLE B. BLOCK C. SQUARE
8. MOON : LIGHT :: ECLIPSE :
A. SOLAR B. BLOCK C. DARKNESS
9. PIPE : WATER :: ARTERY :
A. BLOOD B. VEINS C. OXYGEN
10. WIND : CYCLONE :: SHOWER :
A. CLOUDBURST B. SPRAY C. TORNADO
11. BICYCLE : MOTORCYCLE :: WAGON :
A. CARRIAGE B. HORSE C. AUTOMOBILE

12. FOUR : SQUARE :: THREE :
A. PENNY B. TRIANGLE C. ANGLE
13. LADDER : RUNG :: STAIRWAY :
A. ESCALATOR B. STEP C. RISER
14. SCISSORS : CLOTH :: SAW :
A. BLADE B. CEMENT C. WOOD
15. PENCIL : LEAD :: PEN :
A. FLUID B. PAPER C. INK
16. STATION : TRAIN :: DOCK :
A. PIER B. SHIP C. RAFT
17. TREE : ELM :: FLOWER :
A. GARDEN B. HOLLY C. ROSE
18. COLLAR : NECK :: BELT :
A. WAIST B. BUCKLE C. STOMACH
19. TAPESTRY : WALL :: CARPET :
A. TACK B. FLOOR C. GROUND
20. BAY : OCEAN :: PENINSULA :
A. EARTH B. CONTINENT C. ISLAND
21. PART : WHOLE :: SPOKE :
A. RIM B. LANGUAGE C. WHEEL
22. HANDFUL : PINCH :: SWIG :
A. BEER B. SIP C. GULP
23. LID : BOX :: CORK :
A. CONTAINER B. BOTTLE C. FLOAT

24. DIVIDE : MULTIPLY :: SUBTRACT :

A. COMPUTE B. ADD C. MINUS

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