A Study of the Effects of Jungian Types on Mathematics Achievement of Private High School Girls in North Sydney

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This study investigated the effects of general personality attributes of extraversion and introversion, and mental functions of sensing, intuition, thinking and feeling on mathematics achievement of private high school girls in North Sydney via the Myers-Briggs Type Indicator (Form G). Results of two independent t-tests showed that extraverted girls had significantly lower mean mathematics scores than introverts. Subjects who preferred judgmental processes were found to have significantly higher mean mathematics scores than those who preferred perceptive processes. Further analysis using two 2x2 ANOVAs for modes of perception (sensing-intuition) and judgment (thinking/feeling) yielded a significant thinking-feeling main effect for perceptive subjects. There was no significant results for judgmental subjects. No interaction effect was reported in both cases. Stepwise regression of all independent variables on mathematics scores in the final analysis indicated that only 14% of mathematics performance could be explained by the subjects' perceptiveness of the outer world.

The act of learning mathematics, an abstract discipline, cannot be easily understood unless the mental processes by which information is processed can be identified. As reported by MacKinnon (1960, 1962a, 1962b, 1965, 1971), gifted mathematicians, male or female, tend to be intuitive in their thought processes. Jung (1971:453) regards intuition as a basic psychological function that mediates perception in an unconscious way. In intuition a content presents itself whole and complete, without our being able to explain or discover how this content comes into existence. It is simply that mode of perception that is oriented to possibilities and to seeing hitherto unknown patterns.

Research on cognition of eminent mathematicians indicates a common tension which underlies creative thoughts; the typical feature being the process of 'incubation' (Otte, 1990). Often, having struggled with a problem, mathematicians find that the solution comes to them quite unexpectedly, in a flash, like an intuitive thought. The use of intuition has never been recommended as part of the school curriculum. In school, mathematics is associated with certainty most of the time; that is by knowing it, or with being able to obtain the right answer, quickly (Ball, 1988; Schoenfield, 1985; Stodolsky, 1985). Knowing mathematics means remembering and applying the correct rule to the questions posed by the teacher in daily work, class tests and examinations. One could hardly imagine hearing the words, "maybe" or "perhaps" in a mathematics lesson. Mathematics, to the student, is just not a subject to be explored or created as knowing mathematics in school means "doing" mathematics through watching - observing how the teacher solves the problem, listening and practising.

Otte (1990) claims that the difference between mere understanding and really knowing mathematics is that something like an experiential element which elevates the knowledge to a higher level is added, though it may be partially correct at times. He believes that intuition tends to rebel against constraints necessary to maintain the order and discipline of conventional thought. Examples of the incorporation of intuition in the formation of mathematical theory includes Hilbert's combination of formal theory with intuitive meta-theory and Godel's incompleteness theorem (Otte, 1990).

According to Lakatos (1976), new knowledge in the discipline develops as a process of "conscious guessing" about relationships among quantities and shapes, with proof following a "zig-zag" path starting from conjectures and moving to the examination of premises through the use of counter examples and "refutations". The gap between conceptual approaches on the one hand and constructive, sequential approaches to mathematical problems on the other has been growing, especially in the schools. High schools today do not seem to encourage the conceptual approach or intuitive thinking at all. It is thus not surprising that mathematical creativity has been stifled in the classrooms. This also means that new knowledge in the discipline will need an exceptionally long time to crystalize.

This study aims to relate the intrapsychic functional preferences of teenage girls, as characterized by the Jungian theory, to their mathematical achievement in school. It then examines the current state of achievement of intuitively perceptive girls in mathematics. With the personal characteristics of the gifted mathematician as defined in the literature, the researcher would attempt to identify mathematical talent in the high school whilst it is still in its potential stage.

Jungian theory suggests that individuals differ in how they acquire information from the world around them and how they subsequently make judgements using the data. According to Jung (1971:330), personality traits and behaviour can be explained in terms of distinctly opposite functions of attitude-types of introversion and extraversion, and functional-types of thinking, feeling, sensation and intuition. Jungian psychologists generally view sensing and intuition as perceptive functions while thinking and feeling as judgment functions. Assuming that all mental functions are never distributed uniformly, Jung (1921) postulated that human beings are basically oriented one way or the other on each dichotomy. A person's preference is more or less determined at birth and strengthened through constant usage since the favoured mode is exercised and the less favoured is neglected.

With Jung's theory as a theoretical framework Isabel Briggs Myers (1962) designed the Myers-Briggs Type Indicator (MBTI) which is an empirical instrument to classify people according to the Jungian types. The MBTI serves to identify, from self-report of easily recognized reactions, the basic preferences of people in regard to modes of perception and judgment.

The limited number of studies with high school students using the Myers-Briggs Type Indicator (MBTI) in the last two decades have yielded non-conclusive results. May (1971), in her unpublished Ed.D. Dissertation, conducted an investigation of the relationships between selected personality characteristics, namely sensing and intuition, of eighth-grade students and their achievement in mathematics. One hundred and ninety-five subjects in a junior high school in Florida were administered the MBTI, the Standard Achievement Test, the Dutton Arithmetic Attitude Scale, and the California Test of Mental Maturity. Results of the study indicated that the mean score on the three achievement measures and on intelligence was significantly higher for those students classified by the MBTI as sensing than those classified as intuitive.

Barrett and Connot (1986), who attempted to relate personality types of 383 high school students to their academic achievement and their level of participation in school activities using the MBTI, found intuitives (both intuitive-feelers and intuitive-thinkers) and judgers to top the list of achievers. It was also the intuitive subjects who had the highest involvement in clubs. Sensing groups were found to have the lowest level of participation in co-curricular activities; they also had the lowest academic achievement.

McCaulley and Natter (1974) had reported significantly higher mathematics scores for intuitive nine- and twelfth-graders in comparison to sensing groups. There was, however, no difference in mathematics scores of the "judgment" group and the "perception" group. Hanson and his associates (1984) in a preliminary study, found that gifted students as a single population, are predominantly intuitors.

When examining large populations of high school students (7th-9th graders), Myers (1962) had found 88% of the gifted female population to be intuitives compared to a 30% in the general population. In addition, 42% of the gifted female adolescents were found to be introverts compared to 25% in a typical school setting. Also, 65% of Myers' subjects were perceptives while only 53% in a general population had been found to be of the perceptive type. Unfortunately, no information concerning the particular gifts of the girls (e.g. whether subjects were gifted in mathematics) was documented in Myers' (1962) study.

As quantitative studies relating intuition to mathematics achievement are relatively rare in the literature, this study serves as a pilot project in which relationships between preferred mental functions and mathematics performance in a typical female high school setting are explored. The "mental functions" in the study are those defined by Jung (1921) and Myers (1962). Using Holland's[1] (1973) theory of occupational choice as a parallel, this study **assumes** that students who do not learn or do poorly in mathematics in the high school are likely to be poorly matched with the characteristics and demands of the discipline, and will therefore not pursue mathematics-related careers or aspire to be mathematicians.

This study hypothesizes that high achievers of mathematics tend to be dominantly intuitors as perceivers and thinkers as processors. It specifically addresses the following questions.

(i) Do introverted high school girls out-perform extroverted peers in mathematics achievement?

(ii) Do high school girls who prefer to use 'perceptions' as their dominant mental function achieve better results in mathematics than those who prefer to use 'judgment' as dominant mental function?

(iii) If 'perception' may be normalised into two levels of 'intuition' and 'sensing' and 'judgment' may be categorised into two types of 'thinking' and 'feeling' as postulated by Jung (1921), are there any main or interaction effects of the two independent variables with respect to mathematics achievement for:
   (a) those with 'perception' as dominant process or the 'perceptive type', and
   (b) those with 'judgment' as dominant process or the 'judgmental type'?

(iv) How much of mathematics achievement in the high school could be explained by the Myers-Briggs Type Indicator?

(v) What is the relative strength of each of the Jungian functions of introversion, extraversion, sensing, intuition, thinking, feeling, judgment and perception in predicting mathematics achievement of girls in the high school?

METHOD

Subjects

The subjects were high school students enrolled at a private girls' school in North Sydney, Australia. The school gained accreditation by the New South Wales Department of School Education in the 1960s for having good records in both scholastic and sporting activities. This is a school where creative talents have been emphasized and great encouragement has been given by the Principal for their development. Creative thinking skills including those promoted by Edward de Bono (1986) are taught outside the curriculum and students are given plenty of opportunities to develop their artistic and creative talents through large scale drama festivals and musical performances.

1 Holland's (1973) theory of occupational choice states that individuals select themselves into or have preferences for occupations or academic pursuits on the basis of attitudes, interests, values, personality type and abilities.

One hundred and two subjects from a population of two hundred and ninety-seven year 8 to year 11 students were randomly selected for the study. They were girls from thirteen to seventeen years of age; 80% of whom were Australians, 8% were from Hong Kong, 4% were Japanese, 2% were Iranians, 2% were South Africans, 1% were Britons, 1% were Indians, 1% were Malaysians and 1% were New Zealanders. Data on the occupations of both parents of each subject indicated that none of the subjects were from low socio-economic homes. In fact, 78% of the subjects had fathers who were managers, administrators or professionals.

Procedures

The researcher first assigned a number to all year 8 to 11 students in the target School on class lists. Using the table of random numbers, one hundred and twenty subjects were then identified for the study.

The school counsellor, administered the MBTI to groups of twenty subjects after school hours in the school's "resource" or "counselling" room. Before the test, subjects were told that this is *not* an achievement test and it therefore does *not* have right or wrong answers. They were also told that the MBTI is but an "indicator" of their personal preferences and that individual results would be kept confidential and made available only to the individual. The counsellor would put up charts for all sixteen personality types described by the MBTI so that subjects could read them and find out more about themselves. Further consultation with the counsellor would be made possible by appointments.

The MBTI has no time limit. On the average, subjects took about forty-five minutes to an hour for its completion. The entire data collection procedure spanned over a period of three weeks.

Mathematics achievement was based upon average test and examination scores received by each subject during the first half of the school year. Overall mid-year mathematics results of all students in years 8, 9, 10 and 11 were obtained from the Mathematics Department of the School. Mean math scores for students within a particular class (for all year 8 students) or taking a particular mathematics course (for all year 9 to 11 students) like "intermediate", "general", 'advanced 2 unit", "advanced", "2-unit math", "3-unit math" and "math-in-society" were first computed. These means were then used to standardize the math results of all subjects to Z-scores. Only Z-values of the math scores were used in the final analysis.

The Instruments

The Myers-Briggs Type Indicator (MBTI), developed by Myers and Myers (1962), is used to assess the preferential mental functions of subjects. The MBTI mainly identifies four basic preferences on the indices of EI (extraversion-introversion), SN (sensing-intuition), TF (thinking-feeling) and JP (judgment-perception). Items scored for each index offer forced choices between the poles of the preference at issue. Questions were presented in forced-choice format primarily because type theory postulates dichotomies. All questions offer choices between the poles of the same preference, E or I, S or N, T or F, J or P. No questions cut across preferences. Form G, published in 1977 and is now the standard form of the MBTI, is the official instrument used in this study. It contains research items arranged in such a manner that items which best predict the total type are at the beginning. This format increases the likelihood that respondents who do not finish the test would receive accurate reports of their type.

The test-retest reliability coefficients of the MBTI for females in the age group of 9 to 14 are .78 for the EI scale, .73 for the SN scale, .78 for the TF scale and .84 for the JP scale. For the age group of 15 to 17, the reliability coefficients are .82, .82, .80, .86 for the EI, SN, TF and JP scales respectively (Myers and McCaully, 1985:166). The internal consistency reliabilities of the Indicator are estimated by the coefficient alpha. Samples of the MBTI data bank (Kainz, 1984) reported alpha values of .83, .83, .76 and .80 for the EI, SN, TF and JP scales respectively. Test-retest product-moment correlations of continuous scores for female samples over a period of seven weeks are reported to be .86, .87, .87 and .80 for the EI, SN, TF and JP scales (Carskadon, 1979).

In the Kuder Occupational Interest Survey (Kuder, 1968), mathematics is reported to be positively correlated to the thinking scale of the MBTI (correlation coefficient = .30) at $p<.01$. In the occupational scales of the same survey, "mathematician" is reported to be related to the introversion scale of the MBTI with a correlation coefficient of .22, at $p<.05$. With the Strong-Campbell Interest Inventory (Campbell and Hansen, 1981), the judgement scale on the MBTI has been found to positively correlated to the mathematics interest scales of 848 females at $p<.001$ level. The correlation coefficient reported was .23 in this case.

Research Designs

The correlational method allows the researcher to study patterns of relationships, attributable to individual differences, with respect to mathematics performance. F-tests were, of course, first used to determine the homogeneity of variance or the spread of the means. In the first phase, two independent t-tests were utilized to check if there exist significant differences in the mean math scores of introverted and extroverted subjects, and the mean math scores of perceptive and judgmental subjects.

Two 2x2 ANOVAs were performed in the second stage, one for perceptive subjects and the other for judgmental subjects. In each case, preference scores for sensing and intuition served as levels in the independent variable of "perception" while thinking and feeling preference scores were taken to be the levels in the independent variable of "judgment". Any main and/or interaction effects due to the modes of "perception" and "judgment" were verified in this phase.

A multiple regression model is employed in the final analysis to capture the variations of mathematics achievement in relation to degrees of introversion, extraversion, sensing, intuition, thinking, feeling, perception and judgment. As the researcher has no prior knowledge of the relative importance of the dependent variables, stepwise statistical regression was used.

RESULTS

Table 1 gives the distribution of types in the sample.

TABLE 1: Distribution of types in the sample.

TYPE	PERCENTAGE
Extraverts	70.6
Introverts	29.4
Sensors	44.1
Intuitors	55.9
Thinkers	40.2
Feelers	59.8
Perceivers	65.7
Judgers	34.3

A test on the homogeneity of variance by the F-test showed that the two groups, extroverts and introverts, had different spreads [$F=3.92$, $df=(37,11)$; $p=0.026$]. The result of the t-test indicated that the two groups were significantly different in mathematics performance ($t=3.09$, $df=34.05$; $p<0.004$). The mean figures in Table 2 showed that mathematics scores of introverts were significantly higher than those of the extroverts. It must be noted that the difference in mean mathematics scores became statistically non-significant when the extraversion and introversion preference scores were below 19. Therefore, it can be said that it is only when there exists reasonable probability that the subjects held and acted on the reported preference of introversion and extraversion that they differed in their mathematics performance.

TABLE 2: Table of means of math results of 'extraverts' and 'introverts'

	N	MEAN MATHS (Z-score)	STANDARD DEVIATION
EXTROVERTS (clear to very clear preferences for extraversion: ESCORE > 19)	37	-0.2759	1.184
INTROVERTS (clear to very clear preferences for introversion: ISCORE > 19)	11	0.5425	0.598

TABLE 3: Table of means of math results of 'perceivers' and 'judgers'

	N	MEAN MATHS (Z-score)	STANDARD DEVIATION
PERCEPTION (moderate to very clear preferences: PSCORE > 9)	49	-0.2783	0.992
JUDGMENT (clear to very clear preferences JSCORE > 9)	27	0.2686	0.989

Results of an initial F-test [F=1.01, df=(49,27); p=1.000] showed that the two groups of perceivers and judgers had equal spreads or were homogeneous in the variance of their means.

The result of an independent t-test indicated that the two groups were significantly different in their mathematics achievement (t=2.3, df=74; p<0.024). An examination of the table of means (See TABLE 3) revealed that the perceivers had a significantly lower mean math score than the judgers.

In this case, the perception and judgment preference scores needed only be in the "moderate" to "very clear" preference range (that is, any preference scores greater than 9) for the difference in mathematics means to be significant statistically.

ANOVA for the 'perceptive' type (or those with perception as dominant process)

TABLE 4A: Cell Means for ANOVA of modes of perception and judgment of the 'perceptive' type.

MATH SCORE (means maths scores)		NS		
		INTUITION	SENSING	
TF	THINKING	-0.92	-0.32	-0.68
	FEELING	-0.15	0.49	0.00
		-0.39	0.09	-0.25

TABLE 4B: ANOVA table for the modes of perception and judgment of the 'perceptive' type

SOURCE OF VARIATION	SS	DF	MS	F	P
Main effects	5.011	2	2.505	3.101	0.064
TF	3.733	1	3.733	4.621*	0.042
NS	2.101	1	2.101	2.601	0.120
2-way interactions (TF X NS)	0.002	1	0.002	0.002	0.964

*p<0.05

With the 2x2 factorial design, using sensing and intuition as the two levels in the independent variable of perception, and thinking and feeling as the two levels in the other independent variable of judgment, results of the analysis of variance disclosed that there was a significant difference in math performance of 'thinking' perceptive subjects and 'feeling' subjects [F=4.621, df=(1.98); p<0.05].

There was no significant difference between math performance of the 'intuitively' perceptive and the 'sensing' perceptive subjects, nor was there a significant interaction between their modes of perception and judgment.

ANOVA for the 'judgmental' type (or those with judgment as dominant process)

TABLE 5A: Cell Means for ANOVA of modes of perception and judgment of the 'judgmental' type

MATH SCORE (means maths scores)		NS		
		INTUITION	SENSING	
TF	THINKING	0.53	-0.22	0.08
	FEELING	-0.17	-0.25	-0.20
		0.11	-0.23	-0.06

TABLE 5B: ANOVA table for the modes of perception and judgment of the 'judgmental' type

SOURCE OF VARIATION	SS	DF	MS	F	P
Main effects	0.618	2	0.309	0.202	0.823
TF	0.322	1	0.322	0.210	0.663
NS	0.418	1	0.418	0.273	0.620
2-way interactions (TF X NS)	0.267	1	0.267	0.174	0.691

*p<0.05

A 2x2 analysis of variance was conducted to test the significance of any main or interaction effects of the modes of perception (intuition/sensing) and modes of judgment (thinking/feeling). Table 5 gives an explicit illustration of the results. Neither the main nor the interaction effects were statistically significant.

Multiple Regression

TABLE 6: Reported coefficients of variables in proposed multiple regression equation

Variable	B	F	Sig F
Introversion	0.000428	0.002	0.9690
Extraversion	-0.014413	3.574	0.0618
Sensing	-0.006434	0.377	0.5407
Intuition	-0.003394	0.144	0.7053
Thinking	0.002340	0.055	0.8155
Feeling	0.010120	0.807	0.3713
Perception	-0.016691*	5.515	0.0210
Judgement	-0.006007	0.393	0.5320
CONSTANT	0.543507*	4.029	0.0476

*P<0.05

$R^2 = 0.14361$

Predicted math score, MATH, may be approximately estimated by the equation:

$$MATH_{Z\text{-score}} = 0.544 - 0.017*\text{PERCEPTION PREFERENCE SCORE}$$

It must be noted that the 'perception' variable was negatively correlated to the predicted value of mathematics achievement in the above equation.

DISCUSSION

This study was conducted at a school serving mainly Australian families of fairly high socio-economic status with subjects coming from predominantly white upper and middle-class families.

On the whole, it may be said that this study consisted of mainly extroverted, intuitively feeling girls who preferred to perceive realities rather than to make judgments. Despite the limitations of sampling from a single school, this study demonstrated that high and low achievers of mathematics, for girls at least, do differ on number of aspects like preferences for introversion/extraversion and perception/judgment.

The finding that introverted subjects out-performed extroverted subjects significantly is not a surprising fact since mathematics achievement requires the capacity to deal intensively with concepts and ideas related to the inner world. The nature of the subject matter itself, characterized by number patterns, spatial geometry, logical reasoning, abstract conceptualizations and problem-solving, is inevitably related to the cognitive domain or what Jung termed as the 'inner world'. This is again within the province of introversion. McCaulley and Natter (1974) have also found introverts to score higher in academic aptitude than extraverts, though the difference was not statistically significant in their study. Myers (1962) has also reported similar findings.

When mathematics achievement of subjects with different dominant mental functions were compared, the judging-type subjects were found to be achieving at a significantly higher level than the perceptive-types. This difference was significant at the .05 level.

Among subjects who were perceptive, those who relied on sense-perceptions as their dominant process seemed to have attained a higher level of mathematics achievement than those who were intuitively-perceptive; though the difference was insignificant. May (1971) reported similar findings in her study, though no information regarding the dominant function in her subjects was given. This finding could perhaps be attributed to the fact that at high school level, emphasis on clarity, certainty, accuracy and systematic manipulation might have favoured the learning style of the sensing type.

An alternative explanation could be that the intuitive ability has not been encouraged in the classroom and that little effort has been made by the teacher to match instructional methodology with the learning style of the intuitively-perceptive students. In fact, teachers are most likely unaware of the importance and the significance of the intuitive ability of their students in relation to mathematical discoveries.

Though no interaction effect existed for the perceptives, there was a slight but significant main effect due to the thinking-feeling dichotomy. The perceptives whose auxiliary function was 'thinking' had apparently attained a significantly lower level of achievement compared to those whose auxiliary function was 'feeling'. This finding has at least two implications. It means that either the auxiliary function of 'thinking' in the perceptive-types has been surpressed or under-developed and was thus not contributing to mathematics achievement, or that there were some forms of interference from the dominant perceptive processes of intuition or sensing at the time of testing. An alternative explanation is, of course, the falsification of types resulting from parental pressures and teacher expectations.

For those whose **dominant** function was **'judgment'**, the thinking types appeared to perform better than the feeling types though the difference was not significant. This is an expected finding since mathematics is a discipline involving both deductive and inductive thought processes. By the nature of the subject matter, it is certainly not a discipline where the aesthetic, feeling-type would excel. This finding is also coherent with those of Myers (1962) and MacKinnon (1960, 1962a, 1962b, 1965, 1971), who reported positive associations of the thinking function with creative mathematical ability.

Only 14.36% of the total variance in mathematics achievement of the subjects could be explained by the Myers-Briggs Type Indicator. Apart from the fact that the MBTI contains no questions related to mathematics concepts or intelligence, we know that achievement in mathematics is not a simple construct explainable by the subject's preferential mental functions only. The extent to which a student has aptitude and interest for mathematics, age, motivation, previous achievement, teacher expectation and parental pressure are other factors which need to be taken into consideration when attempting to account for achievement.

Furthermore, type theory predicts that when a student learns something new, he or she will apply the preferred function to the task which seems challenging and exciting. Tasks which appear difficult or uninteresting would be left to the 'jurisdiction' of the auxiliary function. Data on mathematics achievement in the study reported only the end product of these positive or negative learning experiences. As a result, the MBTI does not seem to be able to explain a large portion of the variance in the independent variable.

The only Jungian function capable of predicting mathematics achievement appeared to be the perception scale on the MBTI. It was however, negatively correlated to the predicted value of maths score at .05 level of significance. One may therefore deduce that greater preference for perception is always accompanied by a lower mathematics achievement score. Such a prediction, if could be generalized, certainly implications for the Australian schools. It means that perceptive students who are curious and open to new ideas, according to the type theory, are likely to obtain lower scores in the mathematics class.

In general, the results of this study indicated that high achievers of mathematics in the high school were mainly introverted and had a preference for the judging attitude. Those with thinking as the dominant function and intuition as the auxiliary process appeared to have better mean scores than other groups. On the contrary, those with intuition as the dominant process and thinking as the auxiliary appeared to be the lowest achievers. This is certainly an interesting finding: that the dominance of the intuitive function is actually a disadvantage in the mathematics classroom of today, yet when it is serving as an auxiliary function providing feedback to the dominant thinking function about analytic procedures, excellence in mathematics achievement seems attainable.

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