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Mother and Child as Problem Solving Unit: An Analysis
of the Characteristics and Determinants of
Reflective and Impulsive Behaviour

by

Margaret Kathleen McKim, M.Sc.

A Thesis submitted to the Faculty of Graduate Studies
in partial fulfillment of the requirements for the
degree of Doctor of Philosophy.

Department of Psychology
Carleton University
Ottawa, Ontario
July, 1977

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1977

The undersigned recommend to the Faculty
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"Mother and Child as Problem Solving Unit:
An Analysis of the Characteristics and
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throughout this endeavour.

Forty impulsive and reflective children (20 males and 20 females) and their mothers were administered eight, 16-trial, two-choice, simultaneous, discrimination problems three times using Levine's (1966, 1969, 1975) blank-trials procedure. Subjects' status on the reflective impulsive dimension was determined with the Matching Familiar Figures Tests. Each mother and child worked on a set of problems alone, both before and after an interaction session where they solved problems together. While they worked alone, hypothesis-testing efficiency, problem solving strategies and stereotypes, scanning behaviour, private speech and response times were monitored. During the interaction session as well as measuring problem solving behaviour and response times, mother-child interaction patterns were observed so that estimates of antecedent and consequent stimulus control could be obtained. Following the discrimination problem sessions the children were given a second form of the MPFT to determine if observed interaction patterns could predict which children would show increased reflectivity. Multivariate analysis of variance was the most frequent method of analysis using composite, standardized, continuous indices of the reflective-impulsive status of both mother and child as independent variables. In order to determine the extent to which mothers and children changed their problem solving performance after the interaction session, relative to their before interaction behaviour, standardized change scores were analyzed.

Results indicated that the match between the tempos of mother and child was the single most important factor in accounting for variability

in performance. It was suggested that further study may indicate that the father's status on the reflective-impulsive dimension is an important factor in predicting which children's tempos will be discrepant from their mothers'. Analysis of scanning behaviour indicated that reflective children fixated the correct stimulus proportionately more often following positive than negative feedback. This was interpreted as providing support for the hypothesis that reflective children use a more detailed visual feature analysis technique than impulsives who tend to take a more global approach. Impulsive children with impulsive mothers were found to be less efficient at intersecting information than reflective children regardless of their mother's tempo. This same factor distinguished the performance of reflective and impulsive mothers. While both children and mothers used considerable amounts of private speech while problem-solving, differential use of private speech was not found to predict discrepancies in problem-solving effectiveness. A difference was obtained in the characteristic interaction patterns of reflective mothers and mothers whose impulsive children subsequently showed a change in their tempo status in the reflective direction. It was suggested that impulse control is an effective method of initially changing behaviour toward reflectivity but that indirect strategy instruction is the effective method of maintaining reflective behaviour. Impulsive mothers of impulsive children were found to let their children control the interaction session and were generally less involved in the task than reflective mothers. This study provided support for the expectation that further research should indicate that training mothers to be more aware of and to modify their own behaviour toward their children will prove an effective method of modifying cognitive tempos.

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INTRODUCTION

Since 1964 when Kagan and his associates (Kagan, Rosman, Day, Albert and Phillips, 1964) introduced reflection-impulsivity or cognitive tempo as a major factor accounting for individual differences in information processing, the psychological literature has witnessed a phenomenal proliferation of research in the area. Despite this growing interest the most outstanding characteristic of the research generated since Kagan's initial exposition of the construct is one of confusion — a confusion recently exemplified by an interchange in which the very definition of reflection-impulsivity was questioned (Block, Block and Harrington, 1974, 1975; Kagan and Messer, 1975). In this context previous cognitive tempo research was reviewed in an attempt to provide a much needed perspective on both past and potential future research directions. On the basis of this review research was conducted with the purpose of identifying some critical characteristics distinguishing the performance of reflective and impulsive individuals. Specifically concurrent observations were made of the private speech, problem solving strategies, scanning behaviour and response times of reflective and impulsive children and their mothers. A complementary and equally important goal of this research was to identify some of the natural environmental contingencies which determine whether an individual will display uniquely reflective or impulsive behaviours. A functional analysis of mother-child interaction patterns during problem-solving followed by an examination

of the relationship between particular interaction patterns and later performance was expected to help fulfill this purpose. In the following literature review the significance of this research in furthering our understanding of the role of cognitive tempo in the teaching-learning process will be discussed and as well the rationale behind specific hypotheses will be developed. The review is organized into seven main sections: a) definition and measurement, b) stability and developmental trends, c) significance of cognitive tempo for education, d) further analysis of reflection-impulsivity, e) modification of cognitive tempos, f) determinants of cognitive tempos and g) summary and conclusions.

REVIEW OF RESEARCH ON COGNITIVE TEMPOS

Definition and Measurement

At a descriptive level a reflective individual is defined as one who typically responds slowly, carefully and accurately in problem situations of high response uncertainty. Conversely, in similar situations impulsive individuals are described as responding rapidly without deliberating over alternative responses before making decisions. An individual's status on the reflection-impulsivity dimension, synonymously termed his conceptual or cognitive tempo, traditionally is operationally defined on the basis of performance (total errors and mean response time) on a 12 item match-to-sample task known as the Matching Familiar Figures Test (MFFT). For every

item of the task subjects are required to select from an array of six alternatives the one figure which exactly matches the concurrently presented standard familiar figure. Selection from the alternatives is continued until the single exact match is identified. However, while every incorrect choice throughout the course of the multiple item task is included in the error score obtained, only response time to the first response made to any one item is used in the computation of the mean latency measure. Figure 1 shows a sample item from the elementary school form of the MFFT with the standard on top and the six alternatives below.

In order to classify a subject as being either reflective or impulsive a double median split criterion is used. That is, for each population tested (homogenous with respect to age) a scatter-plot of total number of errors over all items of the MFFT against mean time to first response is generated such that each subject is identified by a single point on the two-dimensional array. A vertical line drawn at the median response time and a horizontal line drawn at the median number of errors divides the scatter-plot into four quadrants with the bulk of individuals usually falling in the upper left (fast and inaccurate) and lower right (slow and accurate) quadrants. The fast but inaccurate subjects are said to exhibit an impulsive cognitive tempo while those who are slow but accurate are identified as reflectives. The mean reported correlation coefficient between time and errors for elementary school children is $-.54$ (Ault, Mitchell and Hartmann, 1976; Egeland and Weinberg, 1976). Figure 2 presents a

Figure 1. A sample item from the elementary

Matching Familiar Figures Test (Form F).

Figure 2. A hypothetical but representative scatter-plot of total errors by mean response time to first response on the Matching Familiar Figures Test. Every point represents one subject. The vertical line drawn at the median error score divides the plot into four quadrants. Subjects in quadrant II (fast and inaccurate) are termed impulsive while subjects located in quadrant IV are classified reflective. Quadrants I vs. III (fast accurate vs. slow-inaccurate) have been reported to represent differences in verbal intelligence (Nelson, 1968; Wright, 1971).

SLOW

RESPONSE TIME (SEC.)

FAST

TOTAL ERRORS

HIGH

LOW

hypothetical but representative scatter-plot of MFFT time and error scores showing the use of the double median split criterion to identify subjects as reflective or impulsive. Some researchers have further complicated the double median split criterion by employing reference populations which are homogeneous not only with respect to age but sex as well. Presumably this additional procedure is based on the assumption that there are sex differences in cognitive tempo. Table 1 summarizes those studies which have reported data relevant to this question. On inspection of Table 1 it may be seen that of the 17 studies summarized there, 12 found no sex differences in measured reflection-impulsivity. Of the five studies obtaining differences, four found females to be more reflective while one reported increased reflectivity in males. However, the sex differences reported by Egeland and Weinberg (1976) were confined to one particular grade-condition subgroup. Other groups in this study receiving the same test did not show these effects. Taken together the 17 studies may be interpreted as indicating that the evidence for sex differences in reflective tendencies is minimal. (See section entitled Modification of Cognitive Tempos for a discussion of sex differences in the modifiability of cognitive tempos.)

Recently Block, Block and Harrington (1974, 1975) severely criticized the use of the double median split criterion for operationalizing the reflection-impulsivity construct. In essence the rationale behind the criticism was derived from an examination of the relationship between certain personality characteristics of preschool children and MFFT error and latency scores, respectively. Using the four

Table 1

Sex Differences in Reflection-Impulsivity

Study	Subject Characteristics (N, mean age (yrs-mos), and/or Grade)	Measure and Criterion used where applicable	Findings
Adams (1972)	- 40 males 40 females - two age groups 40 mean age 6-2 40 mean age 8-4	- Matching Familiar Figures Test (MFFT) - double median split criterion	No sex differences in mean latency or error scores
Ault, Crawford and Jeffrey (1972)	- 15 males 14 females median age, 9-2	- MFFT	no sex differences in latency or error measures
Bjorklund and Butter (1973)	- 72 males 60 females Grade 4	- MFFT - double median split criterion	males made more errors than females
Debus (1970)	- 50 impulsive males 50 impulsive females	- MFFT - median latency criterion only	no sex differences in mean latency scores
Drake (1970)	- 6 males, 12 females median age, 8-11 Grade 3 - 10 males, 6 females undergraduates	- MFFT - median latency criterion only	no sex differences in error or latency scores for either young or adult subjects
Egeland (1974)	- 40 impulsive males 32 impulsive females age range, 6-10 to Grade 2 8-1	- MFFT - double median split criterion	no sex differences in error latency scores
Egeland and Weinberg (1976)	- 76 male, 76 female kindergartners - 72 male, 81 female 2nd graders - 79 male, 72 female fifth graders	- kindergarten (K) and two element- ary (F, S) MFFT forms - two forms (same or different admin- istered one week apart	no significant sex differences in errors or latency at either testing on any test (F, S, K) for K's or 2nd graders Only GS's who received Form F at both test- ings showed sex dif- ferences (i.e. females longer latencies at test 2 and males more errors at both tests)

Table 1 (Cont'd.)

Glenwick and Burka (1975)	- 33 males 20 females mean age 9-5 Grade 4	- MFFT	no significant sex differences in latency or error scores
Harrison and Nadelman (1973)	- 25 males 25 females median age, 4-8	- MFFT - double median split criterion separately by sex	females longer latencies and fewer errors than boys
Kagan et al (1964)	- 60 males 53 females Grade 3	- MFFT - double median split criterion	no sex differences in mean latency or error scores
Katz (1971)	- 33 males mean age 4-7 34 females mean age 4-6 Preschool	- MFFT - double median split criterion separately by sex and combined sample	no sex differences in error or mean latency measures
Kopfstein (1973)		- MFFT	no sex differences in error or mean latency measures
Lewis, Rausch, Goldberg and Dodd (1968)	- 23 males 25 females mean age, 3-8	- Matching Figures Test (four altern- atives shown alone before standard and alternatives shown together- only two choices per item-20 items)	no sex differences in error or latency measures
McKinney (1975)	- 34 males 30 females 7.86 years Grade 2	- MFFT - double median split criterion	no significant sex differences in latency or error scores within R or I groups
Meichenbaum and Goodman (1969)	- 13 males 17 females mean age 5-8 Kindergarten	- MFFT - double median split criterion separately by sex	females shorter latencies than males no sex difference in error scores

Table 1 (Cont'd.)

Schwab (1972)	- 15 moderate impulsives 15 extreme impulsives selected from a total sample of 119 Grade 4 students	- MFFT - double median split criterion plus subdivision of impulsives	more males in extreme impulsive group than females more females in moderate impulsive group than males
Shipman (1969)	- 1399 Preschool children	- MFFT	no sex difference in latency or error measures

quadrants defined by median splits on MFFT latency and errors to derive a 2×2 design Block et al. (1974) computed 100 separate analyses of variance (one analysis corresponding to each personality characteristic). Finding that considerably more significant effects were attributable to MFFT error scores than MFFT response times these authors suggested that the role of response time in defining reflection-impulsivity is minimal. This suggestion must be viewed with scepticism for a number of reasons, however. First, Block et al. (1974) reported that the number of subjects in each of the four quadrants was disproportionate indicating that MFFT errors and latency are not independent. Since it is likely that the overlap of error and latency variance was given to the error variable these authors biased their results in favour of obtaining significant MFFT error main effects. Second, Block et al (1974) computed 100 separate analyses of variance on their data. The high probability of misinterpretations in such correlated, multiple dependent measure situations is well documented (Hummel and Sligo, 1971). Third, as Kagan and Messer (1975) have pointed out the use of preschool children in the study limits the extent to which these results can be considered to have implications for the reflection-impulsivity dimension in general. As we shall see previous research with preschool children in this area has not been consistent.

Stability and Developmental Trends

Twelve-item preschool, elementary and adult forms of the MFFT are commercially available from Jerome Kagan. These tests have been

the most frequently used tools to measure reflection-impulsivity and are thus the best documented. However alternate forms characterized by fewer items (Egeland, 1974) and/or fewer variants (Ward, 1968; Wright, 1971) have been devised by individual researchers particularly for use in pretest-posttest experimental designs. Egeland (1974) divided the two available 12-item elementary forms of the MFFT (Forms F and S) into three 8-item tests for separate usage as a pretest, an immediate posttest, and a delayed posttest. While correlations among the scores obtained on the three tests ranged from .92 to .98 the distributions of response times and errors on these alternate forms are not presently available. While Debus (1970) has reported a correlation of .91 between the first eight items and all twelve items of the children's forms of the MFFT, Ault, Mitchell and Hartmann (1976) have indicated that internal consistency reliabilities for elementary MFFT error scores are lower (coefficient α 's from .32 to .60) than the corresponding coefficients for latencies (e.g. .89). The lack of item and test length standardization of the MFFT is a neglect which must be corrected.

A few studies have examined the stability of elementary school children's MFFT performance over periods ranging from one week to two and one-half years without any systematic intervening treatment. To date the most comprehensive study of test-retest reliability for the MFFT is provided by Egeland and Weinberg (1976). These authors administered either the same or a different form of the MFFT one

week apart to groups of second and fifth grade children. The short-term stability of latencies and errors irrespective of MFFT form, grade or sex ranged from .27 to .88 and averaged .58. In general latency stability increased as grade increased while error reliabilities were highest at the grade two level. An interesting outcome of this study was that while error and latency correlations between Forms F and S were relatively high (mean $r = .58$) Form S was consistently more difficult (more errors and longer latencies) for both second and fifth grade children. It is suggested that if these two forms are used in pretest-posttest designs errors and latencies should be standardized for each test separately before any comparisons are made. To return to the question of the stability of elementary school children's MFFT performance four studies using longer inter-test-intervals than the Egeland and Weinberg (1976) study will be reviewed. Yando and Kagan (1969) tested second grade children each week for 10 weeks on a variation of the MFFT. In the first week subjects were shown a standard and two alternatives, in the second week a standard and three alternatives with one more alternative in subsequent weeks. The median correlation for response time across all weeks was .73 ($p < .01$) and for errors .68 ($p < .01$). In another study (Kagan, 1965b) the standard elementary MFFT form F was administered to 102 Grade 1 children and again a year later. The obtained correlations for response time were .48 ($p < .01$) for boys and .50 ($p < .01$) for girls. The corresponding correlations for error scores were .25 and

.51 . In a study with older children (Grades 3 and 4) Kagan (1965c) found the average response time correlation over one year for both sexes to be .62 . Taken together these studies indicate considerable stability in cognitive tempos for elementary school children over one year. Moreover Messer (1970b) has shown that MFFT performance remains relatively stable over a 2½ year time span. Sixty-five boys were tested on the elementary form MFFT in Grade 1 and were available for retesting in Grade 3. It was found that response times and error scores at first testing were correlated .31 ($p < .05$) and .33 ($p < .01$) with those obtained 2½ years later. While these coefficients are slightly lower than those the one-year studies report, the fact that Messer's subjects were boys and that boys also exhibited the lowest correspondence between MFFT performance separated by one year (Kagan 1965b) might suggest that reflection-impulsivity is less stable for boys than girls. A firm conclusion on this matter obviously requires further research. There is unfortunately no published evidence concerning the stability of adult cognitive tempos.

The stability of preschool and kindergarten children's performance has been examined by a few authors. A test designed for use with preschool children and containing fewer variants than Kagan's MFFT (i.e. the Kansas Reflection-impulsivity Scale for Preschoolers (KRISP), Wright, 1971) has obtained small negative correlations between response time and errors (about $-.11$) and a lack of stability of conceptual tempos over one year in preschool boys (McCluskey and Wright, 1973). Whether these findings reflect the fact that the

KRISP is not a measure of reflection-impulsivity or that cognitive tempo is not a stable characteristic of preschool children is yet to be determined. The finding that young children exhibit a similar instability over one week (Egeland and Weinberg, 1976) and one year (Block, Block and Harrington, 1974) on Kagan's standard 12-item Preschool MFFT would seem to support the later contention. But the Achenbach and Weisz (1975) report of significant correlations between preschooler's error and latency scores over six months on a modified KRISP confuses the issue.

While there are no national norms available for MFFT performance, Table 2 summarizes response time and error data culled from the current literature. It may be seen that in general response times increase in duration with age and the number of errors made decreases. Thus while an individual's position on the reflection-impulsivity dimension remains moderately stable relative to his peers a developmental trend toward reflectivity is also operative.

Significance of Cognitive Tempo for Education

The purpose of this section of the literature review is not only to initiate consideration of the possible significance of reflection-impulsivity to education but to give substance to the rationale behind attempts at modifying cognitive tempos. However, before reflection-impulsivity may be considered a cognitive style dimension worthy of study, its relationship with traditional measures of intelligence must be examined. Obviously if performance differences

Table 2

Means, Medians and Ranges of MFF Response Time and Errors

Complete sample before median split After division into reflectives and impulsives

Subject	Mean			Median		Mean		
	Resp.T. per item	Errors on all 12 items	Resp.T. (secs.)	Errors on all 12 items	Errors on all 12 items	Response Time per item (secs.)	Reflectives Impulsives	Errors on all 12 items Reflectives Impulsives
a)								
Pre-School	5.9	28.6	5.1	31	-	-	-	-
	4.3-7.5	24.5-31.8	-	-	-	-	-	-
N	174			50				
Kindergarten								
	9.5	23.9	6.6	22	13.4	6.1	18.2	29.2
	8.0-15.0	22.2-30.2	-	-	11.9-20.2	5.4-9.0	14.4-25.8	23.2-35.3
N	141			111		109		109
Grades 1-2								
	12.2	13.5	11.3	14.7	20.8	9.9	7.2	24.1
	10.5-15.4	10.9-17.7	10.2-13.8	11-16	-	6.7-11.6	-	21-25.8
N	411		443		30	87	30	87
Grades 3-5								
	16.9	10.4	13.6	7.7	30.0	9.1	5.1	11.4
	13.7-22.6	7.4-14.1	8.0-22.0	5.8-12	21.1-38.6	8.1-17.0	1.8-9.1	8.4-18.0
N	427		423		110	330	110	330
Grade 6								
	10.4	7.8	-	-	-	-	-	-
	(20)	(20)	-	-	-	-	-	-
	1-17	0-20	-	-	-	-	-	-
(N)	(20)	(20)	-	-	-	-	-	-

b)

Table 2 (Cont'd.)

Means, Medians and Ranges of MFF Response Time and Errors						
Mean or Adult	Mean		Median		Mean	
	Resp.T. per item	Errors on all 12 items	Resp.T. (secs.)	Errors on all 12 items	Response Time per item (secs.)	Errors on all 12 items
Range (N)	Reflectives Impulsives		Reflectives Impulsives		Reflectives Impulsives	
	Reflectives	Impulsives	Reflectives	Impulsives	Reflectives	Impulsives
Adult	-	-	27.5 (13)	-	53.8 (21)	16.4 (22)
Range	-	-	-	-	43-89 (15)	11-22 (15)
	-	-	-	-	2.6 (15)	7.8 (15)
	-	-	-	-	0.5 (15)	7-11 (15)

Note 1. Except for the adult section, the figures in the left half of the table are from different samples than those in the right half.

2. The a) section of the table is taken from Messer (1975, personal communication).

on the MFFT can be largely attributed to differences in intellectual ability the utility of cognitive tempos in accounting for error variance presently unexplained through IQ differences is minimized.

In order to test the validity of this hypothesis studies assessing the relationship between measured IQ and reflection-impulsivity were examined. Table 3 summarizes the relevant research. The 16 studies outlined are of two types. Either the correlations between MFFT error scores, response times and IQ scores were computed, or, the IQ's of subjects already classified as reflective or impulsive were compared. Of the seven studies reporting correlations between MFFT error scores and verbal IQ, four found a significant negative relationship and three reported no significant relationship. Conversely, only one of six correlational studies found verbal IQ and MFFT response times to be related. Only two studies have assessed the relationship between MFFT errors, latency and performance IQ. While significant negative correlations between MFFT errors and nonverbal IQ were obtained in both studies this finding was only true for females in one of these. Further, MFFT latencies and nonverbal IQ were only significantly correlated for males in one of the two studies. Correlations between full scale IQ's and cognitive tempo are contradictory: one study reported no significant relationship for either errors or latency and full scale IQ, another study obtained significant correlations between both errors, latencies and IQ scores for females but not for males while yet a third study reported no relationship between errors, latencies and IQ

Table 3

Reflection-Impulsivity and IQ

Study	Subjects (N, sex, grade and/ or age)	Reflection- Impulsivity Measure and Criterion Used (where applicable)	IQ Measure	Findings
Achenbach and Weisz (1975)	-55 males 47 females nursery school	-modified 6-item KRISP (Forms A and B) -administered twice	-Stanford-Binet (short-form) -administered twice	-correlation between MA and errors and latency at both tests higher than correlations between IQ and I-R status -MA at first test predicted KRISP errors ($r = -.63$) and latency at ($r = .32$) second test
Bjorklund and Butter (1972)	-65 males 52 females Grade 4	- MFFT	-Primary Mental Abilities(PMA) administered one year before MFFT	nonsignificant correlations between PMA scores and MFFT errors and latency
Brodzinsky (1975)	-143 males 48 aged 6-0 to 6-11 47 aged 8-0 to 8-11 48 aged 10-0 to 10-11	- MFFT double median split separately for each age group	-Wechsler Intelligence Scale for Children(WISC) Vocabulary Test	no significant relationship between WISC vocabulary and cognitive tempor at any age
Butler (1972)	-15 reflec- tives 15 impul- sives Grade 2	- MFFT - double median split criterion	-California Test of Mental Maturity	-reflectives significantly higher non-verbal intelligence than impulsives

Table 3 Cont'd.

Study	Subjects	R-I Measure	IQ Measure	Findings
Glenwick and Burka (1975)	-31 males 18 females Grade 4 mean age 9-5	- MFFT	California Mental Maturity Test (verbal, non-verbal and total IQ)	-males:significant correlations between a) MFF latency and nonverbal ($r=.31$) and total ($r=.31$) IQ and b) MFF errors and total ($r=-.31$) -females:significant relationship between MFF errors and non-verbal ($r=-.48$) and total ($r=-.50$) IQ
Harrison and Nadelman (1972)	-25 males 25 females median age 4-8	- MFFT	Peabody Picture Vocabulary Test (PPVT)	-MFFT errors negatively related to PPVT IQ ($p<.05$) -MFFT latency not related to PPVT IQ -reflectives had significantly higher IQs than impulsives (males only)
Kagan, Pearson and Welch (1966)	-79 males 76 females Grade 1	- MFFT	WISC Verbal scale	-MFFT errors negatively related to WISC Verbal scores -no relationship with latency
Kagan, Rosman Day, Albert and Phillips (1964)	-30 males 28 females Grade 3 -30 males 25 females Grade 4	- MFFT	WISC Verval scale	-correlation of errors and IQ: Grade 3 males, $-.53$ ($p < .02$), - Grade 4 females, $-.40$ ($p < .05$) -correlation of latency and IQ: non-significant for either Grade or sex

Table 3 Cont'd.

Study	Subjects	R-I Measure	IQ Measure	Findings
Katz (1971)	-33 males mean age 4-7 -34 females mean age 4-6 Preschool	-MFFT double median split combined sample and separately by sex	Wechsler Preschool and Primary Scale of Intelligence (WPPSI)	no significant differences in MFF errors and latency due to IQ
Kilburg and Siegel (1973)	-18 reflec- tives mean age 11-3 -18 impul- sives mean age 11-1 Grade 5	-MFFT double median split	Otis-Lennon	no IQ difference between reflectives and impulsives
Lewis, Rausch, Goldberg and Dodd (1968)	-23 males 25 females mean CA, 3-8	-Matching Figures test (<u>four</u> alternatives presented before standard, only 2 selections per item)	Stanford-Binet (Form L-M) administered 2 weeks before or after MFT.	errors ($r=-.67$) and latency ($r=.45$) significantly correlated with IQ for <u>females</u> only
Meichen- baum and Goodman (1969)	-17 females 13 males Kinder- garten mean CA 5-8	-MFFT double median split criterion separated by sex	PMA	reflectives significantly higher IQ's than impulsives
Plomin and Buss (1973)	-52 Grade 2 subjects	-MFFT	WISC Perform- ance and Verval Scales	-errors significantly related to perform- ance IQ ($r=-.38$) but not verbal or full scale IQ -no latency relationships
Ridberg, Parke and Hether- ington (1971)	-50 reflec- tives 50 impul- sives males Grade 4	-MFFT double median split criterion	Mean IQ from Kuhlman- Anderson and Pinter-Durost Intelligence Tests	-no difference in mean IQ between reflectives and impulsives

Table 3 Cont'd

Study	Subjects	R-I Measure	IQ Measure	Findings
Stein and Prindaville (1976)	-10 reflective males 10 impulsive males Grade 3 mean age 8.74 yrs.	-MPPT double mean-median split criterion	Lorge-Thorndike	no significant difference between R's and I's in IQ or CA
Ward (1968b)	-41 males 41 females Kindergarten mean age 5-9	-Matching Figures Tests (either 3 or 5 alternatives, only one choice per item)	PPVT administered twice (Forms A & B) IQ and MA from mean of two tests	Males: errors on 5 alternative test significantly negatively related to PPVT MA, no latency relationships Females: errors on 3 and 5 alternative tests significantly negatively related to PPVT IQ and MA, latency on MF (5) positively related to MA and IQ

scores obtained at first testing but significant positive relationships between both errors and latencies and IQ for the same subjects six months later. Of the eight studies comparing the IQ scores of reflective and impulsive subject groups five found no difference, two found reflectives to have higher IQ's and one reported that while reflective males exhibited significantly higher IQ's than impulsive males there were no significant differences in the verbal IQ's of reflective and impulsive females. Taken together these sixteen studies do not present a particularly clear picture of the relationship between IQ and reflection-impulsivity. However when procedural differences between studies (e.g. subject characteristics, IQ measure) are set aside, the bulk of the evidence would appear to support the contention that there is little relationship between cognitive tempos and intelligence. Further, it must be considered that: a) the format of the MFFT and KRISP is quite similar to the format of some intelligence tests (e.g. PPVT, Stanford-Binet, Picture Completion subtest of the WISC), and b) without national norms for the MFFT the subject samples employed in the correlational studies may have contained fast-accurate and slow-inaccurate subjects as well as reflectives and impulsives. That is, studies assessing the relationship between IQ and MFFT response times and error scores may in fact be biased toward rejecting the null hypothesis that no relationship exists between intelligence and cognitive tempo. While there is no doubt that further research on this issue is needed it may be concluded that the relationship between intelligence and reflection-impulsivity

is at best tenuous and possibly represents an alpha error. For present purposes it will be assumed that intelligence and cognitive tempo are at least sufficiently independent to warrant further investigation of conceptual tempos. It should be noted however that since reflection-impulsivity is a developmental as well as an individual difference variable, significant mental age (MA) and chronological age (CA), correlations with errors and latencies should not be unexpected. Finding that MA and KRISP errors and latency correlations were significantly higher than the corresponding correlations with IQ Achenbach and Weisz (1975) cautioned that inferences regarding cognitive tempo effects as distinct from general developmental changes are not valid unless the relationship holds true when the overlap with CA and MA is partialled out.

Turning now to research assessing the role of reflection-impulsivity in school performance, studies which have examined the relationship between achievement in reading and arithmetic, reasoning, creativity, classroom behaviour, school failure and cognitive tempo will be reviewed. With respect to reading ability, each of the seven studies reporting data on this question found reflectives to be better readers than impulsives from Kindergarten through to Grade 6. Moreover, the one published longitudinal study (Kagan, 1965b) found that MFFT error scores obtained in Grade 1 were predictive of reading errors committed in Grade 2 on a paragraph reading task. The importance of these findings for education cannot be overly stressed. As Kagan (1965b) points out, poor reading skills are often attributed to a perceptual deficit on the basis of poor

reproductions of Bender-Gestalt drawings. The fact that poor reproduction scores are positively related to fast response times on the MFFT (Kagan, 1965b) would imply that poor reading is due to impulsivity and not a perceptual deficit per se. Table 4 summarizes the research available on the relationship between reflection-impulsivity and reading ability. The one study which has looked at arithmetic achievement and MFFT performance is included in Table 4 as reading achievement was evaluated concurrently. Hallahan, Kauffman and Ball (1973) found that high achievement in both reading and arithmetic was associated with low error scores on the MFFT.

Two studies have assessed reasoning ability in reflectives and impulsives. Kagan, Pearson and Welch (1966) found that on three independent inductive reasoning tests, impulsive Grade 1 children made more errors than their reflective peers even when verbal ability was controlled. Similarly, Fein's (1970) impulsive adults made more errors on Raven's Advanced Progressive Matrices Test than did reflective adults.

It is commonly believed that while reflectives are best at traditional reasoning tasks, impulsives are more creative presumably because of their greater spontaneity. Only three studies have begun to assess this notion however. On tests of creativity both Bierbryer (1972) and Ward (1968a) found no relationship between reflection-impulsivity and creativity while Fuqua, Bartsch and Phye (1975) found reflectives to be more creative than impulsives. Further research is required before any firm conclusion can be made but these findings do

Table 4

Reflection-Impulsivity and Reading

Study	Subject Characteristics (N, sex, age and/or Grade)	Reflection-Impulsivity Measure and Criterion Used (where applicable)	Reading Measure	Findings
Briggs and Elkind (1973)	-32 S's -16 pairs of age-matched early readers and controls -mean age 5-5	-MFFT	-not specified	early readers more accurate on MFFT than controls
Butler (1972)	-15 reflective 'average' readers, -15 impulsive 'average' readers -Grade 2	-MFFT -double median split criterion	-Metropolitan Achievement Test (for subject selection) -California test of Mental Maturity -California Achievement test-Reading -Subjects read aloud	-when IQ controlled reflectives made more repetitions and corrected more miscues than impulsives -MFFT errors and latency correlated ($p < .01$) with corrected miscues
Erickson and Otto (1973)	-80 nonreaders -mean age 5-11 -Kindergarten	-MFFT -double median split criterion	-list of four words presented -word recognition: pick out one of original words from two variants -word generalization: pick out original word from variants differing by one letter	-reflectives made more correct word recognitions than impulsives -impulsives made more false generalizations than reflectives

Table 4 Cont'd.

Study	Subjects	R-I Measure	Reading Measure	Findings
Hallahan, Kauffman and Ball (1973)	-10 high achievers 10 low achievers mean age 12-0 Grade 6	-MFFT	-SRA Achievement series (Reading and Arithmetic)	-high achievers made fewer errors on MFFT than low achievers -no response time relationships
Kagan (1965b) Exp't 1:	-65 males 65 females Grade 1	-MFFT	-letter and word recognition	-significant correlations between word recognition errors and MFF errors (+) and latency (-)
Exp't 2: (6 mo. later)	-54 males 59 females now in Grade 2	-MFFT given 6 months before	-group administered word recognition task	-MFF errors and latency correlated with word recognition errors made six months later
Exp't 3: (1 yr. later)	-46 males 56 females Grade 2	-MFFT re-administered	-paragraph reading	-MFF errors in G.1 and reading errors at end of G.2 related (+)
Roettger (1971)	-57 impulsives -57 reflectives Kindergarten	-MFFT latency criterion only	-Word Discrimination Test	-reflectives made fewer word discrimination errors than impulsives
Yando and Kagan (1968)	-80 males 80 females	-MFFT	-Metropolitan Reading Readiness Test	-reading scores and MFF errors (+) and latency (-) sig. related for girls -reading scores only sig. related to MFF errors for boys

indicate that the previous assumption that impulsives are more creative than reflectives is questionable.

Tests of the external validity of the reflective-impulsive distinction have been conducted by Bjorklund and Butter (1973), McKinney (1975) and Bentler and McClain (1976). In the first study teacher ratings and self-reports of classroom behaviour were correlated with MFFT performance (errors and latency). The only significant finding was that MFFT latency was related to the tendency of Grade 4 children to respond quickly when asked a question in class. Overall classroom behaviour ratings (7-point scale from lethargic to hyperactive) and children's behavioural self-report did not relate to cognitive tempo measures, however. In the second study (McKinney, 1975) it was found that teachers rated second grade impulsive boys as less task-oriented and considerate than reflective children of either sex. Although impulsive girls were reported to be more distractible than reflective girls, boys were rated more distractible than girls regardless of tempo. In the third study (Bentler and McClain, 1976) teacher, peer and self-reports were collected for fifth grade children on extraversion, test anxiety, academic achievement motivation and impulsivity scales. The only significant relationship with MFFT performance was a negative correlation between MFFT errors and peer ratings of extraversion. It is suggested that future research in this area utilize direct classroom observational techniques since ratings may be confounded by the cognitive tempos of the teachers and peers themselves. Indirect support for this conclusion comes from a study demonstrating that the reflection-

impulsivity of teachers influences the MFFT performance of their students (Yando and Kagan, 1968). (See section on the Determinants of Cognitive Tempos for further discussion of this point.)

Only one study (Messer, 1970b) has looked at the extent to which MFFT performance predicts later school failure. Results indicated that boys who failed one grade by age nine had exhibited significantly shorter response times and had made more errors than age matched non-repeaters on the MFFT administered 2½ years previously. It would appear that the MFFT has validity for predicting school success. The relationship between an individual's status on the reflection-impulsivity dimension and school performance has been demonstrated repeatedly. The importance of these findings for education and their role in stimulating research aimed at modifying cognitive tempos is obvious.

Further Analysis of Reflection-Impulsivity

Due to the demonstrated relationship between cognitive tempos and aspects of academic "success", a number of researchers became interested in specifying exactly what differentiates the behaviour of reflective and impulsive individuals. These investigations may be grouped into five main categories; a) investigation of differences in visual scanning behaviour, b) studies concerned with identifying differences in the problem-solving abilities of reflective and impulsive children, c) research on performance

differences in perceptual learning tasks, d) studies of the relationship between cognitive tempos and response to success, failure and frustration, and e) investigations of the private speech and verbal control over motor behaviour of reflective and impulsive children. Findings of research in these areas will be analyzed and discussed in turn with the aim of arriving at a more complete understanding of the substrates of cognitive tempos. Moreover, since these research areas correspond to particular conceptions of the determinants of reflection-impulsivity and are also reflected in some techniques used to modify cognitive tempos, this section will serve as an introduction to later discussion.

Scanning Behaviour

If the literature assessing the scanning behaviour of reflective and impulsive individuals is to provide useful information concerning the microstructure of cognitive tempos beyond what is known about response time and error scores already available from MFFT performance, two conditions must be met. First, to assess whether findings are replicable and conclusions valid there must be some consistency across studies in the measures of scanning behaviour obtained. Second, measures employed must not simply reflect differences in total response time. Obviously if absolute measures are used (e.g. total number of fixations and total time spent observing the standard and the alternatives while completing the MFFT) it is likely that reflectives will score significantly higher than impulsives since

the former group is known to exhibit considerably longer response times than the latter group. In fact, the available literature does indicate that on most absolute measures of scanning strategies (derived from recordings of visual fixations as subjects performed on the MFFT and similar tasks) reflectives do obtain significantly higher scores than impulsives (Ault, Crawford and Jeffrey, 1972; Drake, 1970; Kagan, Pearson and Welch, 1966; Moleskey and Wright, 1973; Siegelman, 1969; Zelniker, Jeffrey, Ault and Parsons, 1972). While these findings have been taken as indicating that reflective individuals have more adequate strategies for searching the stimulus complex, unless similar results are obtained with relative measures of scanning behaviour, these findings do not tell us any more than that differences in total response time are accompanied by quantitative differences in scanning behaviours. Only through the use of relative measures is the possibility of identifying qualitative differences in scanning strategies maximized.

Unfortunately the scanning literature as a whole does not meet these two conditions. There is not only very little overlap between studies in the measures derived to assess scanning behaviour but the majority of dependent measures utilized are confounded with total response time. Of more than 35 different measures, only 11 have been used in more than one study and of these only four are relative measures not directly confounded by differences in total response time. These four measures are; a) proportion or per cent of all

fixations which are directed toward the standard (Ault, Crawford and Jeffrey, 1972; Drake, 1970; Siegelman, 1969; Wright, 1971; Zelniker, Jeffrey, Ault and Parsons, 1972), b) proportion or per cent of all fixations which are directed toward the most frequently observed alternative figure (Siegelman, 1969; Wright, 1971), c) proportion or per cent of all fixations which are directed toward the chosen alternative figure (Siegelman, 1969; Wright, 1971) and d) mean fixation duration (secs.) (Ault, Crawford and Jeffrey, 1972; Siegelman, 1969; Zelniker, Jeffrey, Ault and Parsons, 1972). In contrast to the absolute measures of scanning strategies, analyses of these relative measures have not yielded consistent results across studies. Thus in order to avoid making premature and possibly erroneous conclusions about the differential scanning strategies of reflective and impulsive individuals, relative measures which have been evaluated by only one study will not be discussed. In this context, Table 5 summarizes studies which have used one or more of the four measures listed above. It can be seen on inspection of Table 5 that conclusions drawn on the basis of the results of any one study could be quite misleading. Further research employing these four measures as well as other relative measures of scanning behaviour are needed before any firm conclusions about qualitative differences in the scanning strategies of reflective and impulsive individuals can be made. Those studies assessing the proportion of fixations on the standard figure present the most confusing set

of results. However, Drake's (1970) finding that an analysis of scanning behaviour during the first six seconds yielded different results from an overall analysis might indicate that the distribution of fixations on the standard over time differentiates reflectives and impulsives. That is reflective relative to impulsive children might make proportionately more fixations on the standard figure when an item is first presented compared to the proportion of similarly directed looks just before responding. To conclude this section it must be noted that all of the available scanning studies used separate analyses of variance for each of the many scanning measures derived. Since it has been demonstrated that this substantially increases per comparison and experimentwise error rates (Hummel and Sligo, 1971) conclusions based on these studies must be tentative.

Problem-Solving

Table 6 summarizes the twelve studies which have assessed the problem-solving and the quality of decision-making of reflective and impulsive children. Except for the probability learning studies (Adams, 1972; Fancher, 1969) where the authors suggested that the task was too simple for older subjects and thus did not allow much inter-subject variability all the studies reviewed indicated that reflective children exercised more caution in making decisions and utilized more efficient problem-solving strategies than their impulsive peers. Moreover this increased efficiency paralleled a

Table 5

Reflection-Impulsivity and Scanning Behaviour¹

Study					
	Ault, Crawford and Jeffrey (1972)	Drake (1970)	Siegelman (1969)	Wright (1971)	Zelniker, Jeffrey Ault and Parsons (1972)
Subject Characteristics (N, age and/or grade)	-7 females 11 males median age 9-2	Children -6 males 12 females median age 8-1 Grade 3 Adults: -6 females 10 males	-54 males mean age 9-6 Grade 4	-23 Preschool children 11 impulsives 12 reflectives mean age 9-1 Grade 3	-20 males -20 females (15 reflectives) 16 impulsives) mean age 9-1 Grade 3
Reflection-Impulsivity (R-I) Measure and Criterion used.	-MFFT double median split criterion	-MFFT double median and response time criterion (no difference)	-MFFT double median split criterion	-KRISP double median split criterion	-MFFT double median split criterion
Scanning Task(s)	-MFFT	-MFFT (4 alternatives) -separate analysis for first 6 sec. and overall performance	-MFFT	-KRISP	-MFFT
Results	-no significant difference between R's and I's	First 6 sec. analysis: -young R's and I adults > young I's and R adults Overall analysis: -no significant differences	-I's > R's	-R's > I's	-no significant differences between R's and I's
Scanning Measure	1) Proportion or percent of all fixations which were directed toward the standard.				

Table 5 (Cont'd.)

2) proportion or percent of all fixations which were directed toward the most frequently observed alternative figure	-	- R's > I's	-no significant difference between R's and I's
3) proportion or percent of all fixations which were directed toward the chosen alternative	-	- R's > I's	-no significant difference between R's and I's
4) mean fixation duration (secs.)	-no significant difference between R's and I's	- R's > I's	-no significant difference between R's and I's

1 The studies outlined and results summarized are restricted to those which meet the two conditions discussed in the text.

Table 6

Problem-Solving of Reflective and Impulsive Children

Study	Subject Characteristics (N, age, and/or Grade)	R-I measure and criterion used	a) Problem-Solving task and b) Measures	Findings
Achenbach and Weisz (1975)	-38 reflectives 39 impulsives selected from total sample of 55 males and 47 females preschool	-modified KRISP -double median split criterion	a) choice simultaneous discrimination b) hypothesis (H) use: frequency of same choice over 3 no feedback trials	R's used more H's than I's but no differences when MA partialled out
Adams (1972)	-80 S's 40 age 6 (Y) 40 age 8 (O) equal numbers of male, female reflectives (R) and impulsives (I) at each age level	-MFFT double median split criterion	a) 3-choice, 80-trial, probability learning task, 33 percent reward schedule on 'correct' knob b) 1)perseveration on 'correct' knob 2)patterned sequence 3)win-stay 4)lost-shift	-separate analyses for each strategy 1)Y and I's made fewer errors 2)no overall R-I effect but YR's used pattern more on last 40 trials 3)R's more loses shift than I's 4)YI's more win stay
Ault (1973)	-182 Grade 1, 3 and 5 children -Grade 1, mean age 6-7 Grade 3, mean age 8-8 Grade 5, mean age 10-9	-MFFT double median split by grade	a)20 Questions game b)scoring more points for non-perceptual questions which eliminate a number of stimuli than questions which refer to only one stimulus	-MFFT errors and latency related to 20 questions score -I's lower score than R's -younger B's similar to older I's
Denney (1973a)	-32 males -32 females aged 7 and 8 equal number of males and females in R and I group	-MFFT latency criterion only	a)two 20 Question games and Conceptual Strategy Assessment Procedure (CSAP) b)1)Constant seeking Questions (CS) -eliminates a number of alternatives 2)Pseudoconstraint Question(PS)-same form as CS but only eliminates one alternative	-R's longer latency on CSAP -only percent CS analyzed -R's more CS than I's on 20 Questions and CSAP tasks -no difference in number of questions asked

Table 6 (Cont'd.)

Study	Subjects	R-I Measure	Problem Task	Findings
Fancher (1970)	-48 Kindergarten 48 Grade 4 -24 R's and 24 I's from each grade	-MFFT	a) 3 choice probability learning task, either a 50% reward schedule on 'count' Knob or 100% reward for a patterned response (eg. Rt-middle-left or left-middle-right)	-no R-I or age differences in ability to learn two tasks
Glenwick and Burka (1975)	-33 males 20 females mean age 9-5 Grade 4	-MFFT	a) ability to describe material from perspective of another who has less information b) frequency of intrusion of privileged information	-significant correlations between MFF errors and perspective taking ability for males only
Gozali (1969)	-80 educable retardates mean age 9-3 mean IQ 68	-MFFT -double median split driterion -circular presentation standard surrounded by alternatives	a) MFFT b) position response set (ie. position of chosen alternative same from item to item)	67% of I's used position response set, no R's did
Kagan et al (1965) Study 5	-60 males 53 females Grade 3 & Grade 4	-MFFT administered when S's were in Grades 3 and 4	a) Conceptual Style Test (CST administered when S's were in Grades 2 and 3) b) 1) Analytic; categorization by obvious attribute of stimulus. 2) relational: functional categories 3) inferential: inferred quality categories	no relationship between number of analytic responses and MFFT errors or latency

Table 6 (Cont'd.)

Study	Subjects	R-I Measure	Problem Task	Findings
Mann (1973)	-23 Grade 1 age 6 24 Grade 2 age 8	-MFFT -double median split separately by grade	a) Decision-making tests, 1) toy decision 2) Mischel dilemmas 3) goal-setting game 4) spelling decision b) Degree of caution shown (risk taken) in decision (decision time and content of decision)	-no differences in degree of caution in content of decisions -R's took longer to make decisions than I's
McKinney (1973)	-30 R's 30 I's mean age 7-10 Grade 2	-MFFT double median split	a) 3 Matrix tasks, 16, 4 stimuli in 4 x 4 matrix, locate stimulus b) 1) focusing: test one attribute at a time 2) scanning: test one stimulus at a time (in an order) 3) random: test one stimulus at a time (without order)	-separate analyses for each strategy -R's more focusing -I's more random and mixed and scanning than R's -R's extracted more information -no sex differences or practice effects
Nuessle (1972)	-40 Grade 5 (Y) mean age 10-4 40 Grade 9 (O) mean age 14-5 equal numbers of males, females; R's and I's in each group	-MFFT double median split for each age and sex group	a) 16, 4-dimensional, 2 choice, simulta- neous discriminations b) 1) focusing-extent to which all logically incor- rect hypotheses are eliminated 2) response latency	-Grade and R-I effect O and R's more effective focusers than Y and I's -proficient focusers longer latencies following negative feedback
Stein and Prendaville (1976)	-10 reflective males, 10 impulsive males selec- ted from a total sample of 108 males mean age 8.74 Grade 3	-MFFT double median split criterion	a) successive discrim- ination and general- ization b) 1) baseline response rate, 2) trials to criterion 3) variability of response rate to S- 4) response rate to generalization stimuli	1) no difference between R's and I's 2) R's required fewer than I's 3) I's greater than R's 4) I's higher than R's to all stimuli

similar developmental trend whereby older subjects used more effective strategies than younger subjects. These findings are particularly significant because; a) a variety of tasks and strategy measures were used indicating that the effect is not task specific, b) in contrast to investigations of scanning behaviour these studies used either proportional data or based measures on a fixed number of responses so that response time did not directly confound obtained results and c) reflection-impulsivity would appear to be relatively independent of another cognitive style variable, the way in which subjects categorize or code stimuli (Kagan et al, 1964). Further evidence for the latter conclusion will be discussed in the Modification section. However, the research on problem-solving strategies may be criticized for a reliance on separate univariate tests of each dependent measure since the increased rate of per comparison and experimentwise errors for numerous correlated dependent measures is well documented (Hummel and Sligo, 1971). Multivariate analyses would be more appropriate. Further, the fact that Achenbach and Weisz (1975) found that cognitive tempo differences in the use of hypotheses were obviated when MA was controlled indicates that future research must show that differences between the problem solving abilities of reflective and impulsive individuals are independent of the developmental status of these two groups. In a more positive vein, given that available studies have repeatedly found reflectives to exhibit in general more efficient strategies than impulsives, it

is suggested that further research in this area should be directed toward specifying those component processes necessary for efficient problem-solving which distinguish tempo groups. This is a necessary step if specific substrates of reflection-impulsivity are to be identified.

The blank-trials procedure developed by Levine (1966, 1969, 1975) and used successfully with children by numerous researchers (Achenbach and Weisz, 1975; Eimas, 1967, 1969, 1970; Foreit, 1974; Ingalls and Dickerson, 1969; Gholson and Danziger, 1975; Gholson, Levine and Phillips, 1972; Gholson and O'Connor, 1976; Nuessle, 1972; Rieber, 1969) would appear an appropriate tool for such an investigation. With this method the experimenter may directly monitor the hypothesis (H) that a subject is using at any point during the performance of a two-choice simultaneous discrimination task. Knowledge of the sequence of H's used over a series of problems allows the researcher to assess the ability of subjects to

- a) code the chosen stimulus (eg. large, black, circle on the right),
- b) following negative feedback (i.e. feedback indicating an incorrect choice) recode the stimulus information of the alternate necessarily correct stimulus (eg. small, white, square on the left),
- c) retain the coded and/or recoded information from previous trials and
- d) intersect the overlap of the previous and current sets of logically correct H's to obtain the solution set. Application of the method for the purpose of identifying which of these component processes

necessary for efficient problem solving vary as a function of cognitive tempo is based on the assumption that reflectives and impulsives select and test H's in attempting to solve discrimination problems in an equivalent manner. The fact that both Achenbach and Weisz (1975) and Nuessle (1972) found no difference in the extent to which these two groups used H's indicates that this assumption is likely to be met.

Perceptual Learning and Recognition Memory

One type of perceptual learning implies that the discrimination process involves matching sensory input to a prototype stored in memory such that improved discrimination performance is the result of the development of a memory store of the prototype stimulus through experience. Another implies that discrimination learning ability is determined by the extent to which the features that distinguish various stimuli are identified. In 1965, Pick assessed the use of these two types of perceptual learning in an experiment in which subjects were required to find which of six variants were identical to a standard figure (i.e. an analogue of the MFFT). The stimuli were geometrical, letter-like figures and the variants were transformations of the standard figure. In order to test the extent of prototype learning subjects in one group received the same standards as in the original phase but with different transformations from those seen initially. Subjects in a second group received new standards but with the same types of transformations as those used

originally in order to test the extent of distinctive-features learning. The results showed that the distinctive-features transfer group was superior to both the prototype transfer subjects and a control group who received both new standards and new transformations in the transfer phase. Pick (1965) concluded that distinctive-features learning is essential for improvement in discrimination learning. In a similar experiment Odom, McIntyre and Neale (1971) tested perceptual learning of reflective and impulsive kindergarten children and found that just as for the subjects in Pick's (1965) experiment, distinctive-features learning characterized the performance of reflective children. However, impulsive subjects did not show such a hierarchy of distinctive-features over prototype learning modes. In a related study Zelniker and Oppenheimer (1973) replicated Odom et al's (1971) findings and demonstrated that training impulsive kindergarten children on a task which requires subjects to find a figure which differs from the standard leads to improved distinctive-features learning. That is, the distinctive features - prototype learning hierarchy observed in reflective subjects was obtained with impulsive children when they were trained on a task requiring identification of features which differentiate stimuli. Zelniker and Oppenheimer (1976) replicated these findings and reported that a) the differentiation training procedure used in the 1973 study was more effective than matching training in promoting perceptual learning in impulsive kindergarten children and b) interproblem variability during differentiation training was more effective than

intraproblem variability since the former tended to draw subjects' attention to distinctive features. These findings indicate that the inferior discrimination learning performance of impulsive relative to reflective children may be attributed to differences in preferred modes of perceptual learning. That is a qualitative difference in perceptual learning is implied.

However, recent studies of visual recognition memory in reflective and impulsive children suggest that quantitative differences in feature analysis more adequately characterize reflection-impulsivity distinctions. Kilburg and Siegel (1973) gave reflective and impulsive first and fifth graders a forced-choice recognition memory task in which the number of feature differences and the stimulus name similarity between recognition test items were systematically varied. It was found that the relative ordering of the difficulty of the various stimulus conditions was the same for both reflective and impulsive children indicating that the nature of the search process for these two groups is not qualitatively different. However, reflectives performed significantly better on items for which the only basis for correct recognition was detailed visual feature analysis. A study by Siegel, Babich and Kirasic (1974) supports the latter finding. These authors found that reflective-impulsive differences in visual recognition memory were exhibited only when test items differed in one feature. Performance of items with two or more feature differences did not distinguish reflective and impulsive grade 5 boys. A more recent but related study (Weiner

and Berzonsky, 1975) with Grade 2, 4 and 6 reflective and impulsive children indicates that by Grade 6 reflective and impulsive children display less incidental learning and greater central learning than impulsives. While reflectives showed a trade-off of incidental learning for central learning the impulsives did not exhibit this selective learning characteristic. A significant correlation between cognitive tempo and selective attention has also been reported by Hallahan, Kauffman and Ball (1973). Further, Hartley (1976) has shown that impulsive relative to reflective first, third and fifth graders make more errors on a matching-to-sample task requiring the use of their least perceptually salient dimension. However no differences in matching performance exist between these two groups when the most individually salient dimensions were the basis for the matching solution. For both reflectives and impulsives form and number were of higher salience than colour or position. Together, these studies indicate that reflective-impulsive differences may be attributed to a quantitative difference in the thoroughness of and selective attention in, visual feature analysis. However, the failure of the previously discussed visual scanning literature to provide unequivocal support for this conclusion and the fact that reflective-impulsive differences in performance have been demonstrated repeatedly on discrimination tasks which do not require such detailed feature analysis (Katz, 1971, Nuessle, 1972) would seem to question the sufficiency of this account of reflective-impulsive performance differences.

Private Speech and Verbal Control over Motor Behaviour

The nature and function of private speech or self-verbalizations has been the subject of numerous investigations in recent years. (Beaudichon, 1973; Klein, 1963; Kohlberg, Yaeger and Hjertholm, 1968; Luria, 1961; Piaget, 1947; Vygotsky, 1962). Private speech has been defined as "speech which is not addressed or adapted to a listener (other than the child) and which is carried on with apparent satisfaction in the absence of any signs of understanding by a listener" (Kohlberg et al, 1968, p.692). It has been observed that private speech takes qualitatively different forms as development progresses. While at early ages private speech is self-stimulating and characterized by word play, later it describes on-going activities, then serves to guide behaviour and finally is reduced to inaudible mutterings and appears to be internalized (Beaudichon, 1973; Klein, 1963; Kohlberg et al, 1968; Luria, 1961). Unfortunately there is no published information concerning the spontaneous use of private speech by reflective and impulsive school children while problem solving. The fact that two studies have found reflectives better able to use instructed verbalizations to control motor behaviour suggests that such an investigation might prove worthwhile. Meichenbaum and Goodman (1969) administered two simple motor tasks to reflective and impulsive kindergarten children under either covert or overt verbal self-instruction conditions. The first task was a finger-tapping task in which the child was instructed to tap while saying the words "faster" or "slower" aloud or silently. In the second

task subjects were to self-instruct (aloud or silently) to "push" a lever when a blue light came on and "don't push" when a yellow light came on. The amount of verbal control over motor behaviour was assessed by change from base-line tapping rate in the first task and by the child's ability to respond correctly during the second motor task. While impulsives exhibited a higher operant tapping rate than reflectives, there were no differences in the tapping rates of these two groups under any of the self-instruction conditions. However, impulsives were less able to inhibit responding during the motor depression task than reflectives under the covert self-instruction condition. The latter result has been substantiated in a study by Harrison and Nadelman (1972). These authors found that impulsive preschool children were less able to inhibit motor movement on request than reflective children of the same age. Together these studies demonstrate that verbal control of motor behaviour is less effective in impulsive children than reflective children.

The importance of these results can not be underestimated when the role of mediating verbalizations in discrimination learning is considered. Specifically a verbal mediation deficiency has been invoked to account for developmental trends in discrimination learning (eg. Kendler, 1970). This proposal was based on Flavell, Beach and Chinsky's (1966) distinction between a production deficiency and a control deficiency. A production deficiency refers to a failure of an environmental event, S, to produce a mediator, r, even though the mediator is in the repertoire of the subject. A control

deficiency on the other hand refers to the failure of a potential mediator, r , given that it is produced, to control behaviour, R . Kendler (1970) used these two types of deficiency to describe the stages of mediational development. In the first stage it was hypothesized that children have both a production and a control deficiency. In the second stage, control deficiencies decline but children continue to exhibit a production deficiency. In the final stage, mediational deficiencies are minimized. The relationship between the cognitive style variable reflection-impulsivity and Kendler's conception of the ontogeny of discrimination learning may not be immediately obvious. However it is suggested that the inability of researchers to associate the transition from single-link (S-R) to mediated (S-r-s-R) learning with any particular age group (Campione, 1970; Cobb, 1965; Dickenson, 1966; Kendler, 1970; Mumbauer and Odom 1967) is indirect evidence of the role of cognitive tempo in this transition. That is, it is hypothesized that subjects who mediate are also reflective while single-link responders are more likely to be impulsive. Surely it is not coincidental that impulsives relative to reflectives of the same age exhibit an inability to use verbal instructions to control motor performance (i.e. a control deficiency) and this same variable has been invoked by Kendler (1970) to describe the development of discrimination performance. But verbal control over motor performance may not be quite the same thing as verbal mediation in a discrimination task. In this context an examination

of the manner and extent to which reflective and impulsive individuals produce spontaneous verbalizations during a discrimination task as well as a concurrent assessment of the relationship between private speech and problem solving performance should prove useful.

Anxiety and Response to Failure and Frustration

A number of researchers have examined the relationship between anxiety (either experimentally induced through threat and previous failure or as measured by psychometric tests) and reflection-impulsivity. In 1966, Kagan suggested that reflective children are anxious about making mistakes while impulsive children are more concerned about appearing incompetent by responding slowly. To test this hypothesis Kagan (1966) presented third grade children with a serial learning task under three experimental instructional conditions. A 'threat' group was told that the lists they would receive would be very difficult and that children without good memories do poorly. A 'rejection' group was told that they had done poorly on previous lists and that they must do better in future. A 'control' group was simply instructed to rest before further lists would be presented. It was found that under the 'threat' condition reflective males generally made more intrusion errors and recalled fewer words than any other subject group. Since this finding was not statistically significant and response latency measures were not obtained, Kagan's hypothesis concerning differential sources of anxiety in reflective and impulsive children was neither adequately tested nor indirectly

supported by the 1966 study. However, further evidence of the generality and significance of cognitive tempos was provided here in that the serial learning performance of reflectives was considerably better than their impulsive peers prior to the instructional manipulation.

Further tests of the differential sources of anxiety hypothesis have been conducted by Ward (1968b), Messer (1970) and Weiner and Adams (1974) however. Ward found that following errors, impulsive kindergarten children increased their response times whereas reflective children did not alter their subsequent decision times. Ward interpreted this finding to indicate that impulsives are not more anxious about appearing incompetent by responding slowly. Instead of decreasing response times as the Kagan (1966) hypothesis predicts, the opposite occurred in this situation.

In the Messer (1970) experiment, several weeks after an initial measure of MFFT performance, subjects achieved success or failure during an anagrams task and then were readministered the MFFT. All subjects (reflectives and impulsives) were found to exhibit longer response times on the second MFFT following failure than following success on the anagrams task. Since an analysis of changes in error scores following treatment was not conducted systematically no conclusions can be drawn about this criterion measure of reflection-impulsivity. Further, even though anxiety as measured by the Test Anxiety Scale for Children was not related to reflection-impulsivity,

Messer (1970) concluded that the increased response time following failure indicated that anxiety about performance is related to reflectivity.

On the basis of Messer's (1970) results and the lack of a systematic analysis of MFFT error scores following treatment, this conclusion seems unwarranted. The Ward and Messer studies do show that there is a relationship between threat of actual failure and increased response times, however. Weiner and Adams (1974) attempted to replicate this finding and restated Kagan's originally rather vague hypothesis concerning the relationship between anxiety and reflection-impulsivity in terms of reinforcement history. That is, it was hypothesized that failure produces changes in MFFT performance indicative of reflectivity and that frustration, induced by inconsistent success and failure, changes MFFT performance in the direction of impulsivity. Using an interpolated anagrams task to implement success, failure or frustration treatments Weiner and Adams (1974) found that both reflective and impulsive Grade 4 children significantly increased response times following failure.² Corresponding decreases in errors following failure were not obtained. While frustration tended to decrease latencies on the second administration of the MFFT, no significant change in errors was observed following 'frustration' (or 'success') on the interpolated task. In interpreting these findings Weiner and Adams (1974) suggest that while the relationship between failure and increased response times is a well-replicated

one, the nature of this relationship is unclear. Impulsive children experience a substantial amount of failure and yet maintain their impulsive status relative to their peers. Perhaps consistent, meaningful and immediate positive and negative feedback promotes reflectivity while noncontingent feedback (both positive and negative) or continuous failure yields impulsivity.

Modification of Cognitive Tempos

The rationale behind attempts to modify cognitive tempos has been based primarily on indications that school performance is highly related to an individual's status on the reflection-impulsivity dimension. If the impulsive child is to benefit more fully from traditional education it is argued that either he or the mode of teaching must be altered. Modification of the child's impulsive-reflective behaviour has been the strategy which researchers have adopted exclusively in the past. The specific techniques used to modify tempos have been derived to a large extent from the research just reviewed. Relying heavily on instruction but incorporating modelling and direct reinforcement techniques researchers have strived to increase the response times and decrease the errors made by impulsive children. A large number of studies have been conducted in this context and will be grouped and reviewed here according to the following six types of training techniques: (a) modelling, (b) verbal self-control training, (c) scanning and strategy instruction, (d) indirect scanning training through task manipulations

and (e) latency manipulations. Examination of studies aimed at comparing the relative effectiveness of the various modification techniques will conclude the discussion.

Modelling

Four studies have been reported which use various forms of modelling procedures to manipulate reflection-impulsivity (Debus, 1970; Denney, 1972; Ridberg, Parke and Hetherington, 1971; Yando and Kagan, 1968). These studies are outlined in Table 7a. While all modelling studies reported increased latencies following exposure to a reflective model, only when models verbalized or physically indicated reflective scanning strategies were error scores altered in predicted directions (Ridberg, Parke, and Hetherington, 1971). McLaughlin and Brinley (1973) have suggested that modelling will only be effective if the observer has the cognitive structures available to abstract and generalize information received from the model. This may explain the apparent failure of modelling studies to alter error scores.

Verbal Self-Control Training

On the basis of previous research indicating that impulsives do not exhibit the same degree of verbal control over their motor behaviour as do reflectives, Mechenbaum and Goodman (1971) proposed that training impulsive children to use covert verbal self-instruction should induce more reflective performance. Once again the procedure

Table 7.

Modification of Cognitive Tempos

a) <u>Modelling Study</u>	Subject Characteristics(N, age, and/or Grade level assignment to groups)	R-I measure (Criterion & time of administration)	Treatment a) Model Characteristics b) Modelling Task c) Modelling Conditions	Results
Debus (1970)	-50 impulsive males 50 impulsive females mean age 9,2 yrs Grade 3 S's assigned randomly to 1 of 5 groups	-MFFT(10 items) double median split -Pretest(Form A) -Immediate Post Test (IPT), Form B -Delayed (2½ wks.) Post Test (DPT), Form C	a) Grade 6 models b) MFFT, Grade 6 Form c) 1) reflective model: (R) 25-33 sec. latency -verbalization of scanning strategy -2 errors over 10 items 2) Impulsive model: (I) 8 sec. latency -verbalization of 'fast' strategy -13 errors over 10 items 3) Change Model (Ch) 1 model initially impulsive then reflective 4) Dual Model: (D) 2 models, 1 impulsive, 1 reflective 5) Control: no model	-IPT: females showed increased latencies following R, Ch and D models, males increased latencies after R only -DPT: females maintained increased latencies following C only -errors not affected by treatments -no change following I model

Study	Subject	R-I measure	Treatment	Results
Denney (1972)	-36 analytic 36 relational (Conceptual Style Test) Grade 2	-MFFT -Pretest (Form A) -IPT (Form A)	a) adult female model b) Conceptual Style Test c) 1) Analytic impulsive model: 2 sec. response latency 2) Analytic reflective model: 13 sec. response latency 3) Relational impulsive model 4) Relational reflective model	-tempo of model affected latencies of subjects in predicted direction -no effect on errors -no relationship between style and tempo of subjects
Ridberg, Parke and Hetherington (1971)	-50 impulsive males 50 reflective males Grade 4 impulsives given reflective model, reflectives given impulsive model	-MFFT -Pretest -IPT -DPT (1 wk)	a) 9 yr old male (film) b) MFFT c) 1) Model -no verbaliz- ation, no scanning: impulsive model 7-10 sec. latency, reflec- tive model 25-31 sec. latency 2) Model verbalizes-no scanning: Impulsive model verbalizes- fast response, check few variants, pick 1st seeming correct. Reflective model verbalizes slow response, check all with standard before responding	Reflectives: Both treated and control S's increased errors and latencies at IPT and DPT Impulsives: all models effective in increasing latencies and decreas- ing errors at IPT and DPT -HI IQ impulsive best under scanning or verbalizing model -LO IQ best under combined verbaliz- ation and scanning model

Study	Subject	R-I measure	Treatment	Results
Ridberg, Parke and Hetherington (1971) (Cont'd.)			<p>3) Model scans - no verbalization model uses finger to indicate scanning strategy</p> <p>4) Model verbalizes -scans: combination of 2 and 3</p> <p>5) Control - no model</p>	
Yando and Kagan (1968)	-80 males 80 females -Grade 1	-MPFT (double median split) -Fall (Pretest) -Spring(Pretest)	<p>a) 10 reflective teachers 10 impulsive teachers differing in years of experience</p> <p>b) one year in classroom activities</p> <p>c) No specific modelling treatment</p>	<p>-males and females with experienced reflective teachers showed significant increase in latencies</p> <p>-no error score effects</p> <p>-greatest change in males</p>

Table 7 (Cont'd.)

b) Verbal Self-control Training

Study	Subject	R-I measure and other pre- post treatment measures	Self-control training a) Training tasks b) Treatment groups	Results
Meichenbaum and Goodman (1971) Expt. 1	-8 females 7 males Grade 2 "opportunity remedial class" -IQ above 85	-MFFT (6 items) -Porteus Mazes -WISC subtests (performance) -Classroom observation (time-sampling of inapprop- riate behav- iour) -teacher rating	a) Copying designs Picture completion Raven's Progressive Matrices b) 1) Cognitive self- guidance: E modelled 'slow and careful' verbalizations while doing task, S did same, initially overtly then covertly 4 half-hour sessions (n=5) 2) Attention Control: S did training tasks, no self-instruction training (n=5) 3) Assessment control: received pre and post tests (n=5)	-no change in MFF errors -self-instruction group increased MFF latencies and improved WISC Coding and Picture arrange- ment performance -no change in class- room behaviour or teacher ratings

Table 7 (Cont'd.)

c) Scanning and Strategy Instruction

Study	Subject Characteristics (N, age, and/or grade, assignment to experimental groups)	R-I measure and other pre-post treatment measures	Treatment	Results
Ayabe (1969)	-23 reflectives 23 impulsives Grade 4	-MFFT (double median split) -copy the story test -arithmetic test	a) MFFT b) Reflective and impulsive instructions: 4 scanning rules concerned with number of looks at alternatives and standard, number of alternatives observed, proportion on alternatives c) 3 sessions 1) S prememorized rules 2) E demonstrated rules 3) S practised and praised for using rules	-impulsive training induced MFFT impulsive responding -no effect of reflective training -no transfer to Copy or Arithmetic test
Butter (1971)	-30 impulsive males Grade 3 and 4 Haptic R training, N=10 Visual R training, N=10 Control, no training, N=10	-MFFT -Haptic Matching Test (latencies and errors on both tasks used to define impulsives)	a) MFFT b) Reflective scanning training: scan all alternatives, increase prop. time on alternatives c) more than 1 session	-R training increased latencies and decreased errors on training task -visual training did not influence haptic performance

c) Scanning and Strategy Instruction (Cont'd)

Study	Subject	R-I Measure	Treatment	Results
Nelson (1968)	-reflective & impulsive males Grade 4 all S's given reflective training	-MFFT -WISC Picture arrangement -Subtest	a) MFFT b) Reflective training: compair pairs of alter-natives and eliminate those different from standard c) unknown	-latencies increased for R's and I's -I's decreased errors but R's unchanged -no transfer to WISC subtest (latencies or errors)
Roettger (1971)	-57 impulsives 57 reflectives Kindergarten -three groups: 1) Scanning training 2) Attention control 3) Control	-MFFT -Peabody Picture Vocabulary test (PPVT) (latency on MFFT and PPVT criterion only) -Word Discrimination test	a) Word Discrimination Test (WDT) b) Reflective training: taught scanning strategy of matching words letter by letter Attention control: no scanning training, received task Control: read in library c) unknown	-R's better at WDT than I's both before and after treatment -no difference between Attention and Scanning training effects; both better than control
Seggev (1972)	-60 male impulsives -Grade 2 and 4 -Scanning training (N=30), Control (N=30)	-MFFT -Raven's Progressive Matrices, post test only (3 wks)	a) MFFT b) Scanning training Control received training items but no training c) unknown	-training increased latencies and decreased errors on MFFT -no effect of training on Raven's scores -no age differences in training effect

Table 7 (Cont'd.)

d) Indirect Training-task Manipulations

Study	Subject Characteristics (N, age and/or grade, group assignment)	R-I measure and other Pre-post training measures	Treatment	Results
Schwab (1972)	-15 moderate impulsives 15 extreme impulsives Grade 4 -moderate and extreme I's assigned to one of these groups	-MFFT (double median split) -MFFT and Social Studies test administered 1 & 5 wks after training -groups equated on reading achievement	a) Marching-to-sample (MTS) task with 2 to 6 alternatives b) 1) Gradual Difficulty: MTS problems with increasing number of 'alternatives' 2) Constant difficulty MTS problems with 4, 5 and 6 alternatives 3) Control-MB treatment c) 9 sessions of 15 mins.	-Moderate I's receiving Gradual treatment increased latencies and decreased errors on MFFT (1 wk.) -extreme I's worse than controls following training -no transfer of training to social studies test or MFFT administered 5 wks. later
Zelniker, Jeffrey, Ault and Parsons (1972)	-15 reflectives 16 impulsives -mean age 9-1 -Grade 3 -R's and I's assigned to either DFF or control training	-MFFT (double median) -Reaction time task (post test (RT) only)	a) Discriminating Familiar Figures Test (find alternative that is different from standard) (DFFT) b) Group 1-received DFFT Group 2-(Control) received a form of the MFFT c) one session	-following DFFT training impulsives decreased MFF errors but no change in latency -no effect of PFFT training on reflectives -no difference between trained and control groups on RT task R's better than I's with long preparatory intervals

d) Indirect Training-Task Manipulations (Cont'd.)

Study	Subject	R-I measure	Treatment	Results
Zelniker and Oppenheimer (1973)	-60 impulsives Kindergarten 30 received differential training 30 received matching training and then assigned to one of three transfer groups (N=10)	-MFFT (double median split pretest only) -Post test: matching task followed by one of three transfer conditions 1) Prototype transfer- same standards as matching task but new variants 2) Distinctive features transfer- for new standards same variations 3) Control: new standards new variations	a) Discriminating Familiar Figures test or matching test (letter-like stimuli) b) S's received one of above tests c) one session	-I's who received DFF training made fewer errors on distinctive features transfer vs prototype or control -I's who received matching training did not perform transfer tasks differentially -no effect of training on latencies

Table 7 (Cont'd.)

e) Latency Manipulations

Study	Subject Characteristics (N, age and/or grade, group assignment)	R-I measure (and other pre-post treatment measures)	Delay Procedure a) Training tasks b) delay requirement c) length of treatment	Results
Briggs and Weinberg (1973) Expt. 1	-33 impulsive males 33 reflective males -mean age 9-10 -Grade 4 -S's assigned to one of three treatment conditions equal number of R's and I's in each (n=11)	-MFFT (double median split criterion) -Draw-a-line slowly -WISC Picture Arrangement subtest -Time Estimation (tone duration)	a) Matching task, geometric line drawings, 6 alternatives, 17 items b) 1) 'Fast' Condition: only reinforced if latency shorter than 2 previous trials 2) Slow Condition: only reinforced if longer latency than 2 trials before 3) Control Condition: noncontingent reinforcement but same as other conditions c) one session 20 min. to 1 1/2 hrs. depending on condition	Training phase: marked change in latencies of reflectives under 'slow' conditions; impulsives changed very little regardless of treatment Pre-Post Test - MFFT: all groups showed fewer errors and changed latencies at post test but 'slow' training group showed increased latencies and made fewer errors than 'fast' or control. WISC: 'fast' groups had shortest latencies -no difference pre or post on other measures
Expt. 2	-40 impulsive males 40 reflective males median age 9-9	-MFFT (double median)	a) same as expt't 1 b) used 'slow' condition of expt. 1 and varied type of reinforcement 1) Control: informative feedback only 2) Social reinforcement: verbal approval	Training phase: all groups increased latencies but reflectives changed most MFFT pre-post: no differences in MFFT response time or errors

e) Latency Manipulations (Cont'd.)

Study	Subject	R-I Measure	Treatment	Results
Expt. 2 (Cont'd.)			3) Mastery-achievement: received points and informed how others do 4) Tangible reinforcement: poker chips plus prize c) one session of 20-45 min.	
Denney (1973a)	-32 males 32 females -7 & 8 yrs. -R's and I's assigned to one of 'reflective' training or 'impulsive' training	-MFFT (latency criterion only) pretest only -Pre-post tests: 1) Conceptual Strategy Assessment Procedure (CSAP) 2) 20 Questions task	a) CSAP: S asks questions to identify 'correct' picture b) 'Reflective' training: slow down, take time, be careful instructions 5-7 sec. forced delay 'Impulsive' training: 'Hurry up, ask questions quickly' instruction c) one session	-impulsive instructions decreased use of con- straint-seeking questions and decreas- ed latencies -reflective instructions only increased latencies -no change in effici- ency of problem solving as a result of either treatment -reflectives changed latencies more than impulsives following training
Kagan Pearson and Welch (1966)	-40 Impulsives 20 reflectives (Control, no treatment) Grade 1	-MFFT (double median split criterion by sex) -Picture Comple- tion Reasoning test -Pre-test-fall: post test-spring (6-8 wks after training)	a) Haptic Visual Matching Design Matching Inductive Reasoning b) 10-15 sec. required delay c) 3, 40 min. sessions	-post test MFF and reasoning latencies increased -no change in error scores on either task

Table 7 (Cont'd.)

f) Comparison Studies

Study	Subject Characteristics (N, age and/or grade, assignment to groups)	R-I measure and other pre post measures	Treatment Conditions a) training tasks b) training conditions c) treatment duration	Results
Egeland (1974)	-40 impulsive males 32 impulsive females -age range 6-10 to 8-1 years. -Grade 2 -S's assigned to one of three training conditions (24 S's per cell)	-MFFT (8 items) (double median split) given before and after -IPT and DPT (2 mo.) treatment -Gates-Mac Ginitie Reading Test and Stanford Achievement Test given in Fall & Spring	a) 1) Match-to-sample (MTS), geometric designs 2) MTS with nonsense words 3) MTS recall; standard removed 4) Memory task: draw design from memory 5) Describing geometric designs-number of alternatives gradually increased b) 1) Delay Condition: 10-15 sec. required delay 2) Scanning Condition: 5 rules training homologous part comparisons and elimination of 'different' alternatives 3) Control Condition: no training and did not receive training tasks c) 8 30-min sessions over 4 wks.	-no sex differences in treatment effects MFFT IPT: both trained groups increased latency and decreased errors vs. control group MFFT DPT: only scanning group maintained reduced errors -Reading comprehension of scanning training group better than delay and control groups in Spring

f) Comparison Studies (Cont'd)

Study	Subject	R-I measures	Treatment	Results
Finney (1968)	-56 impulsive males Grade 4 S's assigned to 1 of 4 training conditions	-MFFT (double median split)	a) Raven's Coloured Progressive Matrices b) 1) Required delay 2) Reinforced delay: 1) Symbolic reward (grades) if) Concrete reward (money) 3) Control c) one session	-only required delay increased latency and decreased errors -concrete reward only increased latency -no change in other groups
Heider (1971) Expt. 1	-40 middle class (MC) males 40 lower class (LC) males -age 7 yrs. -10 MC and 10 LC S's assigned to each of 4 conditions	-MFFT admin- istered only once under experimental conditions -no other pre or post tests	a) MFFT b) 1) Control: standard MFFT instructions 2) Required Delay: 35 sec. minimum response time 3) Accuracy motivation: if made 'few' mistakes given free play time 4) Scanning-Strategy instruction: compare standard and altern- atives and identify <u>all</u> differences	-LC more impulsive (errors and latency) than MC -no treatment disting- uished MC groups -Scanning-strategy instruction LC group fewer errors and longer latencies than any other group

f) Comparison Studies (Cont'd)

Study	Subject	R-I measures	Treatment	Results
Meichenbaum and Goodman (1971) Expt. 2	-15 impulsives Kindergarten and Grade 1 -5's assigned to 1 of 3 conditions	-MFFT (6 items) (double median split and all S's had previously not responded to 'go slowly' and carefully' instructions) -S's instructed to transfer training to post test	a) Primary Mental Abilities Picture Matching subtest items from Ravens' Matrices b) 1) Modelling: Model demonstrated search for differences scanning behaviour on all alternatives; social reinforcement for use of E's approach 2) Modelling plus cognitive self-guidance: same as 1 but instructed to self-verbalize overtly than covertly 3) Attentional Control: E demonstrated while verbalizing 'go slowly and carefully' plus social reinforcement c) one session	-MFFT latency: Roth modelling alone and modelling plus self-guidance slower but latter group more than former MFFT errors: only modelling plus self-guidance significantly reduced errors

f) Comparison Studies (Cont'd)

Study	Subject	R-I Measure	Treatment	Results
Scher (1971) in Denney (1973b)	-impulsive grade 3 males assigned to 4 conditions	-MFFT	a) Matching-to-sample task with 2-5 alternatives b) 1) Gradual Difficulty- reward marbles for correct response, items with 2-5 alternatives 2) Gradual Difficulty- withdrawal of re- inforcement: same as 1 but lost marbles for 'incorrect' R's 3) Indirect scanning: successively larger homologous parts of standards and alternatives marble reward 4) Control: simply told about toy reward if post test completed (all S's received toy) c) training continued to criterion of 2 correct R's per item	-control group changed -indirect scanning training most effective in altering both latencies and errors in 'reflective' direction -Both reward and withdrawal of rein- forcement altered latencies but <u>not</u> errors

Note. Unless specified all post tests were administered immediately following training.

was effective in increasing latencies but error scores on the MFFT were not affected (Table 7b). While the rationale behind this particular modification technique is quite distinct from the one on which the scanning training studies are based, the procedural distinction is somewhat vague. Both have instructed subjects to engage in particular scanning behaviours.

The inability to modify MFFT error scores through the encouragement of slow responding suggested to many researchers that the difficulty lay in the differential problem solving strategies and scanning behaviour of reflective and impulsive individuals. Despite the fact that research assessing the scanning behaviour of these two groups has not yielded consistent findings, (not confounded by differences in response times, see section on scanning behaviour), many researchers have attempted to modify cognitive tempos by instructing subjects in "reflective scanning". Table 7c summarizes these experiments. Not surprisingly, findings have been inconsistent. Where treatments have been effective in altering both latencies and errors, experimenters have not systematically controlled the content of instructions so that the specific determinants of the observed behavioural change are presently unclear.

Indirect training-task manipulations

While studies included in this section have not directly instructed "reflective scanning strategies", their stated aim has been to promote a scanning strategy characterized by a search for differences among alternatives. The Zelniker studies were partic-

ularly motivated by the research indicating that impulsive individuals do not engage in as thorough visual feature analysis as reflectives, (see section on Perceptual learning and Recognition Memory). These studies are outlined in Table 7d. While the Zelniker and Oppenheimer (1973) study confirmed that the treatment was effective in producing the desired attention to distinctive features, the expected concomitant beneficial effect on MFFT errors and latencies has not been observed consistently.

Latency Manipulations

Studies modifying response time either through required delay or shaping procedures have consistently shown predicted alterations in post test latencies. Parallel alterations in error scores have not been observed however. Simply providing impulsives with extra time does not appear to be a sufficient condition for eliciting reflectivity. The relevant studies are summarized in Table 7e.

Comparison Studies

Since none of the modification techniques reviewed have been wholly effective but all have met with some success, it is difficult to infer conclusions about the relative effectiveness of particular techniques. In attempting to clarify this situation a number of studies have been conducted which directly compare the various treatment models. These experiments are reviewed in Table 7f. Not

all the appropriate comparisons have been made (i.e. no comparison study has been done using the indirect-task manipulation technique) but collapsing across studies it would seem that impulsives given practice with detailed scanning strategies supplied by the experimenter altered their behaviour patterns in the desired direction to a greater extent than those given any other treatment (i.e. modelling, required delay, delay shaping). A similar conclusion has been made by Denney (1973b). But it is the contention here, that this conclusion is not only meaningless but has served to deter much needed research on the determinants of reflection-impulsivity. Under the guise of scanning training, researchers have bombarded subjects with a wide variety of behavioural guidelines including very specific but often different scanning behaviour rules as well as problem solving strategies (primarily instructions to successively eliminate all disconfirmed alternatives) and even instructions to delay responding. This gross technique may be useful for applied purposes. However, the frequently implied belief that scanning training is operationally and theoretically independent of, and at the same level of abstraction as other modification methods has created a situation in which cognitive tempo researchers currently imply that the success of this modification technique indicates that scanning behaviour is the primary determinant of an individual's cognitive tempo. As we have seen, direct observation of the scanning behaviour of reflectives and impulsives has not clearly substantiated this conclusion (see Scanning behaviour section).

When research attempting to modify cognitive tempos is taken as a whole (irrespective of the particular modification procedure

employed) a number of interesting trends emerge which may prove more helpful in furthering our understanding of cognitive tempos than will discussions of the relative effectiveness of particular training techniques. First, asymmetries in the results of modification studies are evident. Impulsive and reflective subject groups have been observed to be differentially responsive to training. In order to evaluate this subject group asymmetry independently of training conditions only studies using completely counterbalanced designs in which impulsive and reflective subjects have an equal probability of being assigned to either impulsive or reflective training can be considered. Unfortunately only two studies meet this design criterion but their results are quite similar (Briggs and Weinberg, Exp't. 1, 1973; Denney, 1973a). Reflectives trained to hasten or delay responding altered their response times in both directions to a greater extent than their impulsive peers given the same training. A modified version of Whites "temporal stacking" model may be invoked to account for this finding. Following a review of literature demonstrating dramatic developmental changes between the ages of five and seven, White (1965) concluded that the most important change in this period was the attainment of an ability to inhibit the first, and presumably, least sophisticated, response available in the behavioural repertoire. White (1965) suggested that responses of increasing developmental sophistication are maximally available as the interval following stimulus presentation increases. Two findings derived from the cognitive tempo literature suggest

that this model needs revision. First, studies that have required impulsive children to delay their responses have not obtained parallel consistent improvements in accuracy or problem solving efficiency measures. Second, White's model does not predict the observed subject group asymmetry in the modifiability of response times. Why should reflectives more readily delay and hasten their responses than impulsives given the same training? The most parsimonious explanation is that the ability to inhibit responding is a necessary but not sufficient condition for eliciting developmentally more advanced responses. More time simply provides the opportunity but other changes in cognitive functioning must occur before the time can be put to use in producing more efficient and accurate responding. Thus, reflectives more readily alter their response times because the quality of their responses is not totally dependent on this factor. On the other hand, impulsives have no use for the extra time that delay instructions provide because they do not have the necessary cognitive representations. This interpretation assumes that the inability to train impulsives to respond even faster is due to a floor effect.

The degree to which tempos are modifiable has also been found to be dependent on the sex and IQ of the subjects. These asymmetries are particularly interesting since IQ and sex have not been found to reliably predict MFFT performance (see section on the Stability and Development of Cognitive Tempos, Tables 1 and 2). Of three

studies assessing sex differences, two (Debus, 1970; Yando and Kagan, 1968) found males and females to be differentially responsive to training while one (Egeland, 1974) did not. Only one study has assessed the relationship between IQ and the modifiability of cognitive tempos (Ridberg Parke, and Hetherington, 1971). While impulsive and reflective subjects did not differ in IQ before training, a relationship between measured intelligence and the degree of response to particular 'reflective' treatments was observed. (Lower IQ subjects were most responsive to a combination of scanning and verbalization of strategy training while higher IQ subjects did better as a result of either of these two treatments alone.) Obviously, more research is needed to disentangle these sex and IQ asymmetries in modification studies. However, these findings do suggest the possibility that the determinants of cognitive tempos may differ as a function of sex and IQ. While previous research has indicated that sex and IQ do not predict an individual's status on the reflection-impulsivity dimension what is being suggested here is that these subgroups may take different routes to achieve the same cognitive tempo.

The disappointing trend emerging when modification studies are taken as a group is that observed training effects have neither been very persistent (Debus, 1970; Egeland, 1974; Ridberg, Parke and Hetherington 1974) nor have they generalized to tasks which differ from the training task (Ayabe, 1969; Butter, 1971; Maichenbaum and Goodman, 1971; Nelson, 1968; Schwab, 1972; Seggev, 1972; Zelniker

et al, 1972). This conclusion is particularly devastating for those who hoped that training cognitive tempos would allow the impulsive child to benefit more from his/her school experience. There is no doubt that these findings indicate that the rush to modify cognitive tempos has been premature. More than any other factor, the failure of the various techniques to yield long-term transfer of training effects in modification studies points to the necessity for research aimed at specifying the characteristics and determinants of cognitive tempos.

Determinants of Cognitive Tempos

Many studies have been directed toward identifying the critical characteristics which distinguish the performance of reflective and impulsive individuals. A complementary and equally important goal is the identification of the conditions which determine whether an individual will display reflective or impulsive behaviours. It is unfortunate that the latter orientation has frequently been bypassed in favour of tempo training research. While investigations of the substrates of reflection-impulsivity will likely tell us what behaviours must be trained, only an understanding of the environmental conditions under which these behaviours are originally adopted, maintained and developed will tell us how to implement an effective training program.

A number of proposals have been put forward to explain what

determines an individual's status on the reflection-impulsivity dimension. One possibility is that the tendency to be reflective or impulsive is an inherited predisposition. Unfortunately no comprehensive study of the inheritance of cognitive tempos has been reported. However, Buss, Plomin and Willerman (1972) have examined the relationship between 'impulsivity' scores, derived from interviews of mothers, with monozygotic (MZ) and dizygotic (DZ) twins. 'Impulsivity' was defined loosely as the tendency to be impulsive, display a short attention span, bore easily, show a lack of self-control and yield to temptation. Since some of these characteristics in the past have been assigned to individual's categorized as impulsive on the basis of their MFFT performance the results of the Buss et al. (1972) study may be suggestive. It was found that both the MZ and DZ twin correlations for girls were very high (.85 and .78 respectively) while the same two statistics for boys were quite different (MZ - .90; DZ - .17). The authors concluded that both sets of correlations indicate that impulsivity is to a large extent environmentally determined since neither the similarity between the female correlations nor the discrepancy between the male correlations can be accounted for by genetic factors alone.

While Kagan (1966a,c) has even suggested that respiratory rate and body build determine cognitive tempo, his differential source of anxiety hypothesis is the only proposal that has received much experimental interest. Kagan hypothesized that while reflective children are anxious about making mistakes, impulsives are more concerned about appearing incompetent by responding slowly. As

discussed previously this relationship between anxiety and reflection-impulsivity has not been substantiated (see Further Analysis of Reflection-Impulsivity). However, Kagan's proposal has stimulated some interesting research, particularly the work of Weiner and Adams (1974). These authors suggested that failure is an antecedent of reflectivity and frustration, defined as non-contingent success and failure, is the precursor of impulsivity. While the results of their study indicated that a relationship between failure and increased response time exists, no relationship was obtained between failure and error scores. Moreover, experimentally induced frustration did not effect performance. Even if the failure-reflective hypothesis had been confirmed it is difficult to understand why impulsives who by definition experience more failure than their reflective peers, should retain their impulsive status.

These findings as well as the failure of modification studies to produce persistent alterations in cognitive tempos have prompted many researchers to suggest that an examination of the natural environmental contingencies under which reflective and impulsive individuals operate should further our understanding of the determinants of cognitive tempos (eg. Briggs and Weinberg, 1973; Meichenbaum and Goodman, 1969; Ridberg, Parke and Hetherington (1971); Ward (1968b; Weiner and Adams, 1974). Surprisingly only one study (Campbell, 1973) has been reported, which involved direct observation of impulsive and reflective boys (Grades 2 and 3) in interaction with

their mothers. Observations were made in the laboratory while mother-child pairs were engaged in two non verbal and two verbal tasks where one problem of each type was difficult and the other easy. It was found that mothers of reflective boys gave more direct physical help and made more specific suggestions about task solution than mothers of impulsive boys. With respect to the child variables reflective boys made more comments while performing the difficult verbal task than their impulsive peers. No other maternal or child variables differentiated the groups. Analysis of the interview data revealed that mothers of impulsive boys expected their sons to finish high school while mothers of reflective boys expected their sons to attend university. Further, mothers of impulsive boys reported that they engaged in more activities with their sons than did reflective mothers. Campbell (1973) interpreted her results to indicate that mothers of impulsive children do not structure tasks as much as mothers of reflectives because they have lower achievement expectations. This conclusion must be viewed with scepticism however, since the design of the study precluded any assessment of causal relationships.

While Campbell's (1973) research does indicate that mothers of reflective and impulsive children behave differently in some respects it leaves a number of important questions unanswered. First, Yando and Kagan (1968) have demonstrated that the cognitive tempos of children vary as a function of the tempos of the teachers to whom

they are exposed. Moreover, Matekunas (1972) has reported that while the MFFT response times of mothers and sons are positively related the correlation between the error scores of these two groups is not significant. Together these findings suggest that, a) the cognitive tempos of both mother and child may play active roles in determining the nature of their interactions, b) the match between the reflection-impulsivity status of mothers and their children may affect their interactions. For example, mother-child pairs whose tempos do not match (i.e. mother-reflective, child impulsive and vice versa) may show more evidence of conflict (eg. more non compliance on the part of the child and more impulse control statements by the mother) than mother-child pairs whose tempos do match (i.e. mother and child both reflective or both impulsive). Since Campbell (1973) did not analyze observed interaction patterns with respect to the reflection-impulsivity status of the mothers (and therefore did not assess matching vs. non-matching tempo effects) it is possible that significant differences in the behaviour patterns of both mothers and children were obscured.

Second, observed asymmetries in the response of males and females to tempo modification attempts may reveal that environmental contingencies which control reflection-impulsivity are sex-dependent. Campbell's (1973) exclusive observation of mother-son pairs precluded any assessment of this possibility.

Third, differential patterns of parent-child interactions must

have predictive validity if this information is to serve more than purely descriptive purposes. It is quite possible that reflective and impulsive children react to their environments in many different ways. However some of these differences may be more critical than others when it comes to predicting differences in task performance. Campbell (1973) did not assess the relationship between the task performance of impulsive and reflective boys and the observed mother-child interaction patterns. Thus it is impossible to tell whether the greater task structuring imposed by reflectives mothers was reflected in better performance by their sons both on the interaction task and a subsequent task.

Fourth, Campbell's observational procedure did not provide a comprehensive picture of the nature of the observed interaction process. Most studies of parent-child interaction have been interpreted in terms of the effects of the parent on the child's behaviour (see Lytton, 1971, for a review of this literature). However, Campbell (1973) points out that observed interactions could just as easily be viewed in terms of the child's effect on the parent. Following from this analysis, Campbell stated that one purpose of her study was to deal with this issue of the direction of effects during mother-child interactions. But the use of an observational procedure which may be described as two, independent, single-term contingency records of behaviour did not provide the data required to achieve this goal. There is no doubt that during any dyadic interaction sequence the behaviour of each participant affects the behaviour

of the other. It is suggested therefore that a three-term contingency record is most appropriate for dealing with this direction of effects issue. Application of the method involves recording of maternal behaviours in relation to specified child antecedent and consequent behaviours and vice versa (Mash, 1973). In relation to this procedure, the aim of identifying the natural environmental contingencies which control cognitive tempos is achieved since the method yields the required functional analysis of the interaction between members of a dyad wherein estimates of both antecedent and consequent stimulus control may be obtained. Campbell's reliance on an observational schedule which simply provided frequency counts of various discrete behaviours made such a functional analysis impossible.

As yet there remain two untested hypotheses concerning the determinants of cognitive tempos. Both have been stated in terms that require a procedure such as the three-term contingency record for adequate assessment. On the basis of the finding that impulsive children exhibit poor verbal control over motor behaviour, Meichenbaum and Goodman (1969) suggested that an analysis of the behavioural consequences which follow a child's compliance or non-compliance negative commands (eg. "Don't do that") might suggest why for some children (impulsives) the word 'don't' does not have inhibitory control over behaviour. A second hypothesis concerning the determinants of cognitive tempos has been proposed by Wright (1971). This author used the asymmetry in reflective and impulsive children's

response to tempo modification attempts as his rationale. Wright (1971) argued that the asymmetries indicated that the preferred response times of reflective and impulsive individuals are in fact very much longer and shorter respectively, than the times actually exhibited by these two groups. Thus, he surmised that impulsive children have a history of compliance to "slow down" instructions. On the other hand reflectives have conformed to "speed up" commands.

As indicated in the introduction to this section, two complementary aims of reflection-impulsivity research are, a) the identification of those characteristics which distinguish the task performance of reflective and impulsive individuals and, b) the identification of those environmental contingencies which control the adoption, maintenance and development of cognitive tempos. An analysis of the scanning behaviour, problem-solving strategies and mother-child interaction of reflective and impulsive individuals should assist in the achievement of these goals.

Summary and Conclusions

- (a) While an individual's position on the reflection-impulsivity dimension remains moderately stable relative to his peers during the elementary school years a developmental trend toward reflectivity is also operative. The evidence for sex and IQ differences in cognitive tempo is not compelling.

- (b) Cognitive tempo is implicated as a predictor of differential school success. Impulsives are poorer readers and are more likely to fail a grade than reflectives. Peer and teacher ratings of behaviour generally do not confirm performance differences between reflectives and impulsives. However the possibility that the tempos of the teachers and peers themselves affect ratings has not been considered. By using the reflection-impulsivity status of mothers as a variable when analyzing their ratings of the behaviour of their own reflective or impulsive child this hypothesis was examined in the present research.
- (c) Research investigating the scanning behaviour of reflective and impulsive individuals has produced equivocal results. Very few scanning measures have been used in more than one study and a large portion of these have been confounded by differences in reflective-impulsive response times. Moreover all the available studies assessed scanning behaviour on a task similar to the MFFT. Therefore it is difficult to tell which of the obtained differences in scanning are generalizable to other tasks on which impulsives and reflectives perform differently. By using proportional measures of scanning behaviour during a discrimination task it was expected that these problems would be alleviated.
- (d) Recent studies indicate that an individual's status on the

reflection-impulsivity dimension influences the efficiency of problem-solving performance. Two questions remain unanswered.

1) Does reflection-impulsivity have differential effects on specific component processes involved in the solving of a discrimination? 2) Do the distributions of the frequencies with which various problem-solving strategies are used vary as a function of cognitive tempo. Answers to these questions were obtained from the present study.

- (e) On the basis of the fact that reflectives when instructed to verbalize exhibit greater verbal control over their motor behaviour than impulsives, training procedures were developed to teach impulsives to use private speech to guide their performance. It has yet to be determined however whether reflectives spontaneously employ more verbalizations to mediate their behaviour. The possibility exists that the ability to effectively implement an instruction to control motor behaviour through verbalization is not complemented by a natural tendency to use spontaneously produced verbal mediators. Moreover, even if evidence can be provided for a positive relationship between the spontaneous and instructed role of verbal mediators in distinguishing reflective's and impulsive's performance whether impulsives exhibit an inability to produce mediators as well as a deficiency in using them to control behaviour is not known. Since verbal mediation has been suggested to play a major role in the development of discrimination learning, a study assessing

the private speech of reflective and impulsive individuals while performing a discrimination task is indicated.

- (f) While general anxiety does not appear to relate to cognitive tempo, task failure (threatened or real) does predict increased response times. An attempt was made in this study to replicate these findings in the context of a discrimination task in which clear indications of incorrect responding (i.e. task failure) were presented.
- (g) The failure of studies attempting to modify conceptual tempos to yield consistent alterations in behaviour indicates the necessity for research aimed at identifying the determinants of an individual's status on the reflection-impulsivity dimension. A functional analysis of mother-child interactions during problem solving was expected to provide estimates of antecedent and consequent stimulus control of reflective and impulsive behaviour. The literature indicates that the sex, intelligence and tempo of the child as well as the tempo of the mother might be expected to distinguish mother-child interaction patterns. Further it was hypothesized that the match between the tempo of the mother and that of the child might play a role above and beyond the independent contribution of the mother's or child's reflection-impulsivity status.

2

MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-A

METHOD

Subjects

Total Sample

All parents of Grade 3 and 4 children attending an Ottawa, Ontario elementary school were sent letters requesting permission for the participation of their child in the research. (Appendix A contains a copy of the parental consent form.) At the school the 139 children for whom permission was granted were individually administered the Matching Familiar Figures Test (Form F) and the Peabody Picture Vocabulary Test (PPVT) (Dunn, 1959). Using the double median split criterion on MFFT total errors and mean response times subjects were categorized as reflective (N=46), impulsive (N=42), fast-accurate (N=22) or slow-inaccurate (N=18). Eleven subjects' scores fell on the median error line and were excluded from further group comparisons. From the PPVT an estimate of Mental Age (MA) and intelligence (IQ) was obtained. The relationships between Chronological Age (CA), MA, IQ, MFFT (Form F) errors and latency were examined. These correlations together with the total sample means and Standard Deviations (SD) for these variables are presented in Table 8 separately for males and females. The variable labelled DIF1 in Table 8 is a single index of reflection-impulsivity status combining both MFFT error and latency information. This variable was constructed because classifying subjects into four groups using the double median split criterion

assumes that all subjects in a given quadrant have identical scores. This dependency on sample medians creates an artificial grouping which not only magnifies the effect of errors of classification but leads to substantial loss in statistical power. Moreover, if instead of classifying subjects into groups error and latency scores are used as independent variables in an analysis of variance (i.e. using high versus low errors and high versus low latencies) main and interaction effects are confounded since errors and latencies are significantly correlated (for this sample $r = -.46$, $p < .001$). Using these two correlated factors will result in unequal cell sizes unless some subjects are discarded. For these reasons a single composite reflection-impulsivity score was created for each subject by taking the difference between the standardized MFFT (Form F) total error and mean latency scores. With this procedure the traditional median split criterion for distinguishing between reflectives and impulsives is maintained since reflectives scores (mean, -1.69; SD, 1.26) do not overlap those of impulsives (mean, 1.79; SD, 0.93). (Fast-accurate and slow-inaccurate subjects DIF 1 scores centred around zero). Further, the continuous nature of the reflection-impulsivity dimension is also maintained allowing for differentiation of subjects within each category in terms of their degree of reflectivity. It can be seen from Table 8 that subjects DIF 1 scores were highly related to MFFT (Form F) error and latency scores for both males and females. This finding further substantiated the validity of this

Table 8

Total Sample Matching Familiar Figures Test (MFFT, Form F)

Total Errors (Errors 1), Mean Response Time (Latency 1), Chronological Age (CA), Peabody Picture Vocabulary Test (PPVT), Mental Age (MA) and IQ Means, Standard Deviations (SD) and Pearson Correlation Coefficients for Males (Below diagonal) and Females (above diagonal).

Females (N = 69)

	CA	MA	IQ	Errors 1	Latency 1	Dif 1
	Mean 8.80	Mean 9.68	Mean 106.54	Mean 8.46	Mean 13.61	Mean -0.04
	SD 0.77	SD 1.97	SD 14.11	SD 4.64	SD 7.30	SD 1.87
CA						
mean 8.87		.40***	-.02	-.37***	.04	-.23*
SD 0.60						
MA	.42***		.89***	-.36***	.13	-.28*
mean 10.47						
SD 1.34						
Males IQ	-.10	.83***		-.21*	.08	-.17
mean 113.60						
(N=70) SD 10.10						
Errors 1	-.39***	-.28**	.09		-.54***	.87***
mean 8.30						
SD 4.36						
Latency 1	.15	.30**	.24*	-.38***		-.88***
mean 12.83						
SD 5.97						
DIF 1	-.33***	-.35***	-.20	.84***	-.82***	
Mean 0.04						
SD 1.55						

* $p < .05$ ** $p < .01$ *** $p < .001$

composite index as a measure of reflection-impulsivity status. While for easy interpretation of Figures subjects scores were divided into reflective and impulsive subgroups all analyses of experimentally obtained data were performed using the continuous DIF 1 score as an estimate of reflection-impulsivity status unless otherwise specified.

Returning to Table 8, it can be seen that the relationship between errors and IQ for females and between latency and IQ for males just reached significance. However, similar relationships were not obtained for the sample as a whole (i.e. irrespective of sex) and the four groups (reflectives, impulsives, fast-accurates and slow-inaccurates) did not differ from one another in intelligence. An overall sex difference in PPVT IQ was obtained. Since France (1973) has also observed a superiority for males on the PPVT at the grade 3 and 4 level it may be surmised that this sex difference in intelligence is attributable to the test used rather than a true, unique characteristic of the present sample of 139. But a relationship between MA, CA and cognitive tempo is not so easily explained. As previously noted Achenbach and Weisz (1975) found MFFT performance to be more highly related to developmental status than intelligence. The present data confirm this result. Both CA and MA were significantly related to DIF 1 scores. This relationship was not unexpected given that a developmental trend toward reflectivity exists. Since the purpose of the present research was to examine the role of reflection-impulsivity in accounting for individual differences in behaviour any overlap of MA and CA with the measures obtained during the present

research was removed before analysis. No sex differences in MFFT (Form F) total errors or mean response times were obtained.

Experimental Sample

For comparability to previous research, the experimental sample of 40 children was selected on the basis of the double median split classification. That is, 20 reflective children (10 males and 10 females) and 20 impulsive children (10 males and 10 females) were randomly selected for participation in the second and major portion of the research. The only restriction here was that the mothers of these 40 children also had to be willing to participate in the study. The MFFT (Form F) errors and response time data as well as the PPVT performance and CA information available for the 40 selected children were reanalyzed. The correlation between MFFT errors and response time for this sample was highly significant at $r = .65$. Just as for the total sample, the only sex difference was in IQ: males had significantly higher scores than females irrespective of tempo group. Further CA and DIF 1 score ($r = -.34$, $p < .02$) and MA and DIF 1 ($r = -.37$, $p < .01$) were highly related for the sample of 40 as a whole. These findings were interpreted as indicating that the selected sample of 40 children were a representative sample of reflectives and impulsives from the total group of 88.

The 40 mothers were individually administered the adult form of the MFFT at the beginning of the experimental session conducted at Carleton University, Ottawa, Ontario. Since the mothers were not a

random sample of adults but were selected on the basis of their childrens' MFFT performance and their willingness to participate in the research, application of the double median split criterion was not considered appropriate. However a standardized composite difference score (DIF M) was constructed and used as an estimate of the mother's reflection-impulsivity status in all analyses of experimentally obtained data. However, as expected the mothers' MFFT response times (mean 54.70 seconds) were significantly longer than those obtained by their children (mean 13.26 seconds) at the initial school testing. But the mean total error scores of these two groups were comparable (mothers 8.58; children 8.83).^a It must be remembered though that the children were given a different (i.e. considerably easier) form of the MFFT than the mothers. This finding points up the need for a reevaluation of the combined use of the elementary, Form F and the adult form of the MFFT as instruments for assessing developmental trends in reflection-impulsivity.

Since Matekunas (1973) had indicated that only the response times of mothers and sons are significantly related, separate correlation coefficients were computed between the MFFT times, errors and composite scores of mothers and children as function of the sex of the child. In the present study none of these correlations proved significant. The only correlation approaching significance was that between mothers response times and the error scores of their daughters. ($r = .36, p < .06$).

Pretraining Apparatus and Stimulus Materials

Four simultaneous discrimination problems were presented during Pretraining. The stimuli varied on the following four bi-valued dimensions; figure (dog or boy), orientation (up or down), perimeter-shape (hexagonal or square) and colour of lower border (red or blue). Figures were centred on white cardboard with the borders located on the lower edges of the stimuli when the figures were oriented in the 'up' position, (i.e. the figures 'stood' on the border). These stimuli were mounted on 2.54 cm. wooden cubes and placed in a flat-grey wooden tray large enough to hold five pairs of cubes. Beneath each cube was a depression into which a marble could be placed. Stimuli were paired vertically so that right-left position could not be a confounding dimension during pretraining.

Experimental Apparatus and Stimulus Materials

Series of eight simultaneous discrimination problems were presented during the experimental phases of the study. These stimuli varied along a different set of four bi-valued dimensions; brightness (black or white), form (circle or square), size (large or small) and position (right or left). All stimulus slides were centred on a medium grey background. Large forms were three times the size of small forms.

Stimulus slides were back projected on to two frosted glass screens (15.24 cm. square and separated by 15.24 cm.) housed within a flat-grey wooden box (60.96 cm. in height) placed on a table.

Simultaneous presentation of the stimulus slides was obtained by placing shutters directly in front of the outermost lens of the two projectors. A small opening just above the bottom centre line of the box allowed subjects to see and reach the marbles (positive feedback) dispensed one at a time into a compartment recessed behind this opening. Located at the centre of the box (equidistant from the two stimulus screens and marble receptacle) was a small speaker through which a tone indicating an incorrect response (negative feedback) could be presented. The subject sat directly in front of the stimulus presentation box on a chair whose height could be adjusted so that the stimulus screens were within easy reach for all subjects. To the subjects' left was a Sony camera standing slightly behind the front of the stimulus box. A microphone was suspended from the ceiling above the subjects' head. When mother and child were working on the problems together (Interaction phase) the mother sat on a chair to the child's right. Digital programming equipment controlling the timing of the shutters, projector advance, and delivery of feedback as well as response recording equipment (i.e. Sony video tape recorder, response time and position (right or left) of response recorders) was located in a control room separated by a wall containing a one-way window from the subject and stimulus display box.

Pretraining and Experimental Problems

While the pretraining and experimental problems differed with respect to the amount of feedback provided to the subject, the dimensions characterizing the stimuli and the apparatus employed to present them, both sets of discriminations used the same rules for determining which stimuli were paired and the order in which these

pairs were presented. Thus, the following description pertains to both the pretraining and experimental problems.

With four binary dimensions, there are exactly eight possible stimulus pairs in which one value of each dimension (e.g. large black circle on the left) is contained in one stimulus of the pair and the remaining value of each dimension is contained in the other (e.g. small, white square on the right). These eight stimulus pairs may be grouped into two sets of four pairs each, one of which, set A (from the experimental problems), is depicted in Figure 3. Set B was constructed simply by reversing the left-right positions (experimental problems) and red-blue border colours (pretraining problems) of set A stimuli. All discrimination problems consisted of outcome trials on which feedback was given and blank trials on which no feedback was given. Blocks of four blank trials were separated by one feedback or outcome trial. The set of stimuli designated as set A were assigned to the blank trials while the remaining set of stimuli (set B) were assigned to the feedback trials. This procedure ensured that for any one problem a stimulus pair for which feedback had been given was never presented on a blank trial.

It is possible to determine the specific hypothesis (H) that a subject is using on a given sequence of four blank trials given that the stimulus set is characterized by internal orthogonality (i.e. levels of any one dimension are paired an equal number of times with the levels of every other dimension). Figure 3 shows that each of the eight possible hypotheses has a distinct left-right pattern of responding

Figure 3. A sample sequence of four blank trials. The right-left response patterns associated with each of the eight possible hypotheses are indicated.

over the four sample/blank trials depicted there. Distributions of three responses to one position and one response to the other position (i.e. 3-1 pattern) indicate inconsistent H manifestations during blank trials of the experimental problems.

The procedure for extrapolating H information is founded on the assumption that subjects respond on the basis of a single H throughout the course of any block of four blank trials. This assumption was one of the major reasons both for including an extensive pretraining phase and on feedback trials of experimental problems for prolonging stimulus presentation for three seconds after the response and reception of feedback. Moreover, it is known that children often display response sets of position alternation (Jeffrey and Cohen, 1965; Osler and Kofsky, 1965; Reiber, 1966; Weir, 1964). Thus, in order to minimize the effect of this type of confounding, position was an irrelevant dimension during the pretraining problems and the eight possible H's corresponded to 3-1 patterns such that inconsistent H's were characterized by position alternation (i.e. the same response distributions had different meanings during the pretraining and experimental problems).

The order of presentation of stimulus pairs within any block of four blank trials was randomly determined with the following restriction. Each stimulus pair of the set of blank trial stimuli appeared an equal number of times in the same position (in the sequence of four blank trials) as every other stimulus. This action minimized the possibility that subjects developed sequential stereotyped strategies (e.g. 'on every

third blank trial choose the stimulus on the right').

The order of presentation of feedback stimulus pairs (Set B) throughout the course of a problem was also random but the following restrictions were placed on this order:

- 1) Any series of three feedback trials logically defined the solution. That is, no stimulus pair was repeated in any series of three feedback trials.
- 2) No stimulus pair appeared more frequently than any other in the same position in any sequence of four feedback trials.
- 3) Each set of four sequential feedback trials contained all possible feedback (Set B) stimulus pairs. This restriction ensured that each feedback stimulus pair would be seen an equal number of times throughout the 16-trial experimental problems.

By using these rules for constructing and ordering particular stimulus pairs the experimenter could infer from the pattern of right-left choices made by a subject over several trials, which particular H the subject was using at that point in the problem. Since it was a sequence of responses which defined an H, the experimenter only gave feedback to the subject concerning the accuracy of his/her responses every fifth trial. Obviously if feedback was given on every trial the subject was likely to alter H's on the basis of feedback information before the experimenter had a chance to identify the H in use.

Each experimental problem consisted of 16 stimulus pairs

similar to those depicted in Figure 3. In each problem there were four feedback trials (trials 1, 6, 11 and 16) interspersed between three sets of four blank trials (trials 2-5, 7-10, 12-15). Feedback (a marble for a 'correct' response or a one-second tone for an 'incorrect' response) was given on a prearranged schedule regardless of the subject's responses. The following arrangements of 'correct' (+) and 'incorrect' (-) feedback over the first two outcome trials were randomly assigned (albeit the same random order for all subjects) to experimental problems with the restriction that each arrangement appeared twice in a set of eight problems; $++$, $+-$, $-+$, $--$. The third outcome trial in every problem was always negative (-) so that responses to every problem had an equal probability of being included in the problem-solving strategy analysis. (See Appendix B.) On outcome trial four (trial 16), positive feedback (+) was given for all choices. This procedure assured that all subjects received an equal number of positive and negative feedback trials by the end of eight problems.

Procedure

Table 9 presents a schedule of experimental events indicating the timing and location of each phase of the study for the mother and child, respectively.

The study was conducted in two sessions. In the first, 139 Grade three and four children were administered the matching Familiar Figures Test (MFPT, Form F) and the Peabody Picture Vocabulary Test (PPVT, Dunn, 1959) at an Ottawa, Ontario suburban school. Using the

double median split criterion on MFPT errors and response time the experimental sample of 20 reflective and 20 impulsive children (10 males and 10 females in each group) and their mothers were selected for participation in the second session.

The second session of the study was conducted at Carleton University, one to four months after session one, and required a total of approximately one hour and fifty minutes for each dyad. All subjects were tested on weekends in a random order within the restraints of the subjects' availability. As indicated in Table 9, session two was divided into six parts. In Part A the mother and child were told the purpose of the study ("to understand how parents and children alone and together go about solving problems"), and what they would be asked to do in the various parts of the session. An extensive pretraining procedure followed. During the pretraining the mother was asked to watch closely while the child and the experimenter worked through four practice problems. Pretraining served three purposes; a) to introduce subjects to the general nature of subsequent experimental problems (i.e. Subjects were expected at the end of pretraining to understand that of four bi-valued dimensions the goal on any one problem was to discover which value was 'correct'), b) to introduce subjects to the blank trial procedure in order to maximize the probability that they would consistently apply the same H in any block of four blank trials (i.e. the number of consecutive blank trials was gradually increased during pretraining from zero on problem 1 to four on problem 4. Pretraining problems had 'real' solutions, contrary to experimental problems, and

Table 9
Schedule of Experimental Events

TIME	CHILD	MOTHER	
Session 1	Event	Place	Measures
A(10 min)	administration of MFFT (Elementary, Form F)	school	MFFT total errors and mean response time
B(10 min)	administration of Peabody Picture Vocabulary Test (PPVT)	school	IQ estimate
(variable interval)			
Session 1 Total Time: 20 min.			
Session 2			
A(10 min)	discrimination pretraining	laboratory (Rooms A&B)	discrimination Laboratory pretraining (Rms A&B)
B(20 min)	administration of 8, 16-trial discrimination problems	laboratory (Room A)	problem-solving behaviour, scanning behaviour, private speech, response times
C(20 min)	rest period: film	laboratory (Room C)	administration Laboratory of 8, 16-trial discrimination problems
			problem-solving behaviour, scanning behaviour, private speech, response times

TIME

CHILD

MOTHER

Session 2	Event	Place	Measures	Event	Place	Measures
D(20 min)	Mother-child interaction during problem solving	Laboratory (Room A)	problem-solving behaviour, mother-child interaction patterns, response times	Mother-child interaction during problem solving	Laboratory (Room A)	problem-solving behaviour, mother-child interaction patterns, response times
E(20 min)	administration of 8, 16-trial discrimination problems	Laboratory (Room A)	problem-solving behaviour, scanning behaviour, private speech, response times	Questionnaire on interaction session D	Laboratory (Room B)	Mother's ratings on interaction patterns
F(20 min)	administration of MFPT (Elementary, Form S)	Laboratory (Room B)	MFPT total errors and mean response time	administration of 8, 16-trial discrimination problems	Laboratory (Room A)	problem-solving behaviour, scanning behaviour, private speech, response times

Session 2 Total time: 1 hr. 50 min.

subjects continued to respond until a criterion of five consecutive correct responses was made and both mother and child were able to verbalize the solution.) and c) to minimize the probability that position alternation response sets would be used during the experimental problems by never reinforcing these types of responses. The last part of the pretraining introduced both mother and child to the experimental apparatus located in a separate room. The experimental stimulus dimensions and potential solutions were described and subjects received one 16-trial practice problem. In order to respond subjects were told to "push in" the screen on which the picture they wanted to select was located. The meaning of the marble and tone feedback was explained and repeated at each practice problem outcome trial.

During part B of the experimental session the child worked on 8, 16-trial simultaneous discrimination problems alone (Child Before) while the mother was administered the adult form of the MPFT.

With a brief reminder as to the nature of the problems and the meaning of the feedback the mother completed eight 16-trial problems alone during Part C (Mother Before). At the same time the child watched a film and received a small toy for participating in the study.

The mother and child worked together on eight 16-trial problems during Part D (Interaction). While the mother sat to the right of the child and the stimulus display box, all mothers could easily reach the response screens. The experimenter instructed each mother-child pair "to work together on the problems as you would if you were doing

something together at home".

In Part E the child completed eight more problems (Child After) while the mother completed a questionnaire concerning her impressions of the preceding interaction session.

During the last phase of the session the mother did eight problems (Mother After) while the child was given a second MFFT (Form S).

Response Measures

As indicated in Table 9, every time the child or mother worked alone on a set of problems the same set of four types of response data was obtained; problem-solving behaviour, scanning behaviour, response times and private speech.

Problem Solving Behaviour

Blank Trials Consistency. In order to evaluate the validity of the assumption that subjects used H's consistently during a block of blank (no feedback) trials, the proportion of these blocks following positive (+) or negative (-) feedback where right-left response patterns represented one of the eight possible H's was determined.

Hypothesis-testing Efficiency. These response measures are defined in Table 10 and were evaluated for the purpose of determining the extent to which subjects efficiently used the component processes considered necessary for effective problem-solving (i.e. win-stay, lose-shift, coding, recoding, retention and intersection) (Introduction,

pg. 39). All hypothesis testing efficiency and blank trials data were normalized before analysis using arc sine transformations. In addition a subset of those measures defined in Table 10 was used to create a measure of the number of H's held by a subject after a given negative feedback outcome trial relative to the number of logically correct H's after that outcome trial. For example, following negative feedback on the first outcome trial (trial 1) only four H's remain as logically correct. The proportion of H's used by a subject which were logically correct (eg. .66) by being divided by the actual number of logically correct H's (in this case, four) determines the size of the H set from which the subject samples following an error at the first outcome trial ($4/.66 = 6$). Similarly the size of the H set following the second and third negative outcome trials was calculated using two and one as the size of the logically correct H sets, respectively. Since these three measures were derived directly from the negative feedback measures 2, 5 and 6 defined in Table 10 a separate analysis of this data was not conducted. However, these measures were used to depict certain obtained significant effects resulting from the analysis of Table 10 data.

Problem Solving Strategies and Stereotypes. The technique for categorizing performance as manifestations of particular strategies or stereotypes parallels the method used to detect H's. An H is inferred from a sequence of responses and a strategy or stereotype is inferred from a sequence of H's. Table 11 contains the names, brief definitions and examples of the six strategies and/or stereotypes classified in the present study. In order from most to least efficient

Table 10

Definitions of Hypothesis Testing Measures

Positive Feedback

1. Win-stay: Proportion of times that an hypothesis was immediately repeated when feedback was positive i.e.

$$\Pr(H_i = H_{i-1} / F_i = +)$$
2. Coding: Proportion of H's logically consistent with the information given on the immediately preceding feedback trial when that feedback was positive.
3. Coding-Retention 1: Proportion of H's logically consistent with information given on a positive feedback trial when one further feedback trial and four blank trials have intervened between the positive feedback trial and H in question.
4. Coding-Retention 2: Proportion of H's logically consistent with information given on a positive feedback trial when two further blocks of trials (i.e. two feedback trials and two sets of blank trials) have intervened between the positive feedback trial and the H in question.
5. Coding-Retention-Intersection 1: Proportion of H's logically consistent with information given on both the first and second feedback trials when the first feedback trial was positive.
6. Coding-Retention-Intersection 2: Proportion of H's logically consistent with information given on feedback trials 1 through 3 when the first feedback trial was positive.

Negative Feedback

1. Lose-shift: Proportion of times that an H was not immediately repeated when feedback was negative.
i.e. $\Pr(H_i \neq H_{i-1} / F_i = -)$
2. Recoding: Proportion of H's logically consistent with the information given on the immediately preceding feedback trial, when that feedback was negative.
3. Recoding-Retention 1: Proportion of H's logically consistent with information given on a negative feedback trial when one further feedback trial and four blank trials have intervened between the negative feedback trial and H in question.
4. Recoding-Retention 2: Proportion of H's logically consistent with information given on a negative feedback trial when two blocks of trials have intervened between the negative feedback trial and H in question.
5. Recoding-Retention-Intersection 1: Proportion of H's logically consistent with information given on both the first and second feedback trials when the first feedback trial was negative.
6. Recoding-Retention-Intersection 2: Proportion of H's logically consistent with information given on feedback trials 1 through 3 when the first feedback trial was negative.

Table 11
Strategies and Stereotypes; Definitions and Manifestations¹

Strategy or Stereotype	Example of Manifestation					
	F_1	H_1	F_2	H_2	F_3	H_3
Focusing (Fo)	+	H_1 (large)	-	H_j (white)	-	$(H_k = H_j^+)$ (circle)
Dimension Checking (D-Ch)	+	H_1 (large)	-	H_j (white)	-	H_2 (right)
Hypothesis Checking (H-Ch)	+	H_1 (large)	-	opH_1 (small)	-	H_j (white)
Stimulus Preference (S-P)	+	H_1 (large)	-	H_1 (large)	-	H_1 (large)
Hypothesis Alternation (H-A)	+	H_1 (large)	-	opH_1 (small)	-	H_1 (large)
Random	+	H_1 (large)	-	H_j (white)	-	H_1 (small)

1. Note: H_1 = an H from the i^{th} dimension; opH_1 = the other H from the i^{th} dimension; H_j = an H from the j^{th} dimension; etc.

the three strategies are Focusing (Fo), Dimension Checking (D-Ch.) and Hypothesis Checking (H-Ch.). The three remaining categories are considered stereotypes since none could logically provide a solution to a problem. The Random category was used as a catch-all for any sequence of H's that did not fit any other category. However, this category was most frequently assigned when it appeared that the subject attempted a Fo or D-Ch strategy but failed to follow through to a successful manifestation of these most efficient methods of solving problems. Appendix B contains a more detailed description of the protocols and corrections used to identify the frequency with which these strategies and stereotypes were employed. Since subjects could demonstrate a maximum of eight strategies or stereotypes for any set of eight problems, individual subject distributions of responses over the six categories would have been meaningless. Therefore the relative frequency with which the various subject groups used the six categories was the response measure derived for further analysis.

Scanning Behaviour

While the mothers and children worked alone on problems a camera was focussed on their eyes so that fixations to the right and left presented stimuli could be monitored trial by trial. Ten percent of eye fixation videotapes were coded by two independent observers. Even though the first observer did not know which subjects tapes would be used for reliability purposes the percent agreement between the two observers was relatively high with a mean of 89.36 and a range from 84.38 to 95.31. A total of four measures were derived for analysis

purposes from the coded fixation data.

First trial. The first set of measures was centred on the scanning behaviour of subjects on the first trial of each of the eight problems in a set. These measures were the total number of fixations on stimuli before the first response and the proportion of fixations to the subsequently chosen stimulus.

Post-Feedback Interval. The second set of measures examined the scanning behaviour of subjects in the fixed three-second interval immediately following feedback when the just responded to stimuli remained in view. These measures were the proportion of all fixations to the correct stimulus following positive feedback and the proportion of fixations to the correct stimulus following negative feedback in the three-second interval.

Response times

Subjects' response times (elapsed time from stimulus onset to response) were divided into three independent categories.

First trial. This included the time subjects took to respond on the first trial of each of the eight problems.

Feedback type. Excluding the first trial of each problem, the set of 15 remaining trials may be considered as three blocks of five trials where the first four trials are blank (no feedback) and the last trial is a feedback trial (F). Five separate mean response times could then be derived for individual subjects, corresponding to the five trials within any one block.

(i.e. 1,2,3,4,F). Actually, two sets of five means were calculated to evaluate whether the response times in blocks immediately following positive feedback were different from those times observed after negative feedback. In order to equate the number of observations entering into the calculation of each mean (eight per mean) only the response times observed in blocks one and two were considered since all subjects received negative feedback on the trial immediately preceding the third block.

Feedback Sequence. Only the response times of the third block were included in this measure. As previously stated all subjects received a prearranged schedule, one of four types of feedback sequences, (++, - +, + - or - -), on the first two feedback trials and all received negative feedback on the third. Since there were eight problems every subject received each feedback sequence twice. In order to evaluate whether the sequence of feedback types effected response times five separate mean response times were calculated representing the five trials within the third block (i.e. 1, 2, 3, 4, F) for each of the four feedback sequences (+ +, - +, + -, - -). The feedback sequences have been listed here in an order from the least to the most number of sequential negative feedbacks.

Private Speech

A microphone suspended from the ceiling above the subject's head transmitted anything said while subjects worked on the problems alone to the videotape recorder located in the control room. While

very few subjects actually noticed the microphone none could have failed to see the camera located at eye level. It could then perhaps be argued that anything subjects said while working on the problems alone was really a form of social speech and not private speech at all.

However in a pilot study the camera was placed behind the one-way mirror for one group of subjects while for a second group it was in the same room as the subject. No differences were found between the two in either amount or type of speech produced. The reason for having the camera in the room at all was simply to improve the quality of the picture particularly for the purpose of detecting eye movements.

The children in the present study were slightly older than those normally used in studies of private speech but both Beaudichon (1973) and Kohlberg et al (1968) had noted that difficult tasks tend to extend the age at which private speech is observed. These studies certainly did not predict the fact that the mothers in this study would use as much private speech as their children however. Consequently the private speech of both children and mothers while they were working alone on eight problems was transcribed from the videotapes and then coded in to one of the following thirteen categories.

1. Social Speech: Any verbalization directed toward the experimenter loud enough to indicate that it was intended as social speech. All subjects were instructed that if they needed to talk to the experimenter while they were working on the problems they could just speak loudly and the experimenter would be able to hear from across the hall. The few subjects who did exercise this ability made their social speech substantially louder (to say the least) than any other verbalizations produced in the session.

2. Word Play: Words, phrases or sounds repeated for their own sake.

For example,

- a) " z z z z ... "
- b) "do - do - do ... "

3. Remarks Addressed to Non-human Objects: Any statement, command question or negative which was directed toward an inanimate object. For example,

- a) "You get in there."
- b) "Let me count you."
- c) "Don't do that."

4. Describing Own Activity. Remarks about the subject's own activity which communicated no information which was not apparent from watching him/her. The description had to be in a form which did not have task solving relevance or planning function. It was in the present tense. For example,

- a) "Here it is."
- b) "I am doing this."

5. Questions Asked and Answered by Self: For example,

- a) "What do I do now? Do this."
- b) "I wonder if I'll get it right this time? I did."

6. Self-guiding Comments: The difference between this category and Describing Own Activity was that these verbalizations had to be task oriented and preceded the activity. For example,

a) "Try the black ones."

b) "Go for this one."

7. Self-Commands: Task irrelevant commands addressed to self. Self Guiding Comments took precedence over this category. For example,

a) "Sit up straight!"

b) "Hurry up."

8. Conclusions: Statements made in the three second interval immediately following feedback which otherwise would be considered Self Guiding Comments. This category also included any statement made at any other time presented in a semi-logical (often negative) form indicating that the subject had arrived at a tentative conclusion about the solution. For example,

a) "It can't be black."

b) "If it's not black then it must be white."

9. Feedback Speech: Statements directly referring to the positive or negative feedback indicators (i.e. marbles or tones). For example,

a) "I've got four marbles so far."

b) "Not another beep."

10. Emotional Expressions: All other categories took precedence over this one. Emotional expressions could be either positive or negative in tone. For example,

a) "Oh boy!"

b) "Damn!"

11. Incomprehensible Speech: Statements which could be heard but not understood principally because they were said too quickly or were overridden by the sound of projectors advancing or a marble being delivered etc.
12. Neutral Speech: Any statement not having emotional or informational value but may express interest or attention. For example,
 - a) "Hmm ..."
 - b) "Oh".
13. Inaudible Muttering: Movements of the lips not accompanied by any discernible sound. A distinct pause in lip movements had to be observed before a second Inaudible category could be assigned.

Reliabilities for the private speech observations were done in two ways. First, for ten percent of the sample two observers independently transcribed the videotapes and then coded their own transcriptions into the various private speech categories. Second, for 100 percent of the transcribed tapes the two observers independently coded the speech into the categories. In both cases, reliabilities were computed for each category of speech as the percent of final category assignments for which both observers agreed divided by the sum of the percent disagreements and agreements. As might have been expected reliabilities obtained from the first method were somewhat lower than those obtained by the second. Agreement was greater than 80 percent for all private speech categories with either method however.

Since reliabilities did not significantly differ as a function of sex, reflective-impulsive status or age (mother-child) only the mean percent agreements across all subjects for each category are reported here.

Method one mean percent agreements are indicated in parentheses in the following list; Word Play 96.20 (92.54), Remarks Addressed to Non-Human Objects 94.33 (89.01), Self Questions 95.45 (90.13), Self Guiding Comments 91.24 (85.63), Self-Commands 89.20 (83.12), Conclusions 88.90 (85.92), Feedback Speech 87.55 (81.20), Emotional Expressions 90.43 (82.74), Incomprehensible 88.13 (80.98), Neutral 98.10 (84.72), Inaudible 83.01 (80.23). Reliabilities were not obtained for the Describing Own Activity category since the frequency of this category was not significantly greater than zero. For all subjects the percentage of their total private speech falling into the various categories was the data employed for all analyses. In addition to these measures the actual total amount of private speech produced by each subject was analyzed.

Mother-Child Interaction

During the interaction session as well as monitoring the response time and problem solving behaviour measures previously defined, mother-child interaction patterns were observed. The observational procedure employed made possible the recording of behaviours in relation to specified antecedent and consequent environmental events. Video-tapes of particular mother-child interaction sessions were coded by

two observers. The first observer recorded behaviours on the Child's Consequent Behaviour Record (Matrix 1 in Appendix C) with nine possible antecedent mother behaviours as column headings. The second observer recorded behaviours on the Mother's Consequent Behaviour Record (Matrix 2 in Appendix C) with the Child's behaviours as antecedents and the mother's behaviour as consequents. A time-sampling observation method was employed. Each observer placed the number one in a matrix cell after the first 10 seconds of the session. Only the first behaviour unit to occur in the interval was recorded. Following recordings there was a 5 second pause and then the second 10 second interval began and was concluded by the observers marking a two in a matrix cell. Observations discontinued when 50 such recordings had been completed. The beginning and end of each 10 second observation interval was indicated by a 'beep' superimposed on the twenty minute mother-child interaction sequence. Appendix C contains a complete copy of the instructions provided to the observers who carried out the observations. The behaviour categories included in the schedule were selected following a review of the procedures used by previous researchers of mother-child interaction during problem solving (i.e. Bee, 1967; Bee et al 1969; Baumrind and Black, 1967; Bing, 1963; Brophy, 1970; Campbell, 1973; Davis and Lange, 1973; Deschner, 1972; Hess and Shipman, 1965; Mercurio, 1972; Solomon et al 1971; Terdal, Jackson and Garner, 1975). These categories were modified slightly following analysis of pilot data to take into account special characteristics of the interactions due to the nature of the particular task employed in the present study. While evaluation of the hypothesis that reflective children have a history of

conforming to "speed up" instructions while impulsives are more experienced with "slow down" commands was expected the frequency with which either of these was used was too small to warrant separation into two categories. Consequently these two types of behaviours were joined to make a single category called Impulse Control Statements. Definitions of the mother and child behaviours included in the observational matrices are provided below.

Maternal Response Classes

1. Indirect Help: Statements which did not suggest a particular response or solution to the problem but took the form of a general strategy suggestion or list of alternate solutions. For example,
 - a) "If this is wrong then we can try one of the sizes or positions."
 - b) "OK, we can try black, circle, white or on the right."
2. Question: Scored in this category were any direct questions not of the command-question type. For example,
 - a) "What were you going to do?"
 - b) "Do you remember?"
3. Praise: The praise category included both verbal and nonverbal actions indicating encouragement, acceptance, and/or approval of the child's behaviour. For example,
 - a) "You're doing well"
 - b) "Good".
4. Neutral: Any general statement about the task or the child's behaviour that did not have strong emotional overtones but expressed interest or attention. For example,
 - a) "mm" "hmm"

- b) "OK".
- 5. Negative: Verbal statements and nonverbal actions indicating discouragement, non-acceptance, and/or disapproval of the child's behaviour. For example,
 - a) "No, you're wrong."
 - b) "I told you so".
- 6. Direct help: Direct help was scored only when the mother actually responded for the child or specifically told the child which stimulus to pick. For example,
 - a) "Push the black one".
 - b) "Try this".
- 7. Impulse Control: Any statement aimed at inhibiting the child's immediate behaviour. Impulse control most frequently took the form of controlling response times (slower or faster). For example,
 - a) "Wait".
 - b) "Hurry up".
- 8. Conclusion: Any statement made in a semi-logical form (often negative) which implied that the subject had decided on a tentative solution to the problem.
 - a) "It can't be black".
 - b) "It must be large then".
- 9. No response: No Response was scored when during the 10 second interval the subject made no task related responses. For example,
 - a) "Do up your shoelaces."
 - b) "What did you eat for breakfast."

Child Response Classes

The categories of Impulse Control, Conclusion, Negative and No Response for the child paralleled those defined under maternal response classes and will not be defined again here. Five other response types were specific to the child however.

1. Compliance: Compliance was scored when the child's behaviour was in response to the mother's Direct Help or Impulse Control statement. Any response ranging from approximation to full compliance was classified as compliance.
2. Independent Responding: This was scored when the child was responding to the stimuli on his/her own and not interacting with the mother.
3. Task Suggestion: Any statement made by the child in which a suggestion concerning a particular solution or a general strategy was made. Examples are,
 - a) "I think we should try black."
 - b) "Remember that left is still a possibility."
4. Interaction: Interaction was an attempt to initiate or maintain some type of mutual contact and included asking or answering questions.
5. Comments: Any statement made by the child obviously not directed to the mother. These took the form of one of the private speech categories previously defined. Comments took precedence over No Response.

Ten percent of the interaction sessions were coded twice by each of two observers who in their training had previously reached a

reliable mean 90 percent agreement. Agreement was scored only if both observers had the same observation number in the appropriate response category. Tapes selected for reliability checks were selected randomly without the knowledge of the observer who had done the original coding. Mean percent agreements over all categories ranged from 78 to 100 with a mean of 85.71.

The data derived for analysis from these observations were the frequency that each subject (mother or child) used the nine response categories as an antecedent or consequent (i.e. 18 frequency scores for each member of a dyad). A further six specific indices were created. These are defined below.

1. Mother's Question Efficiency: The percent of the mother's Questions answered by the child.
2. Mother's Impulse Control Efficiency: The percent of Mother's Impulse Control statements followed by Compliance by the child.
3. Mother's Direct Help Efficiency: The percent of mother's Direct Help followed by compliance by the child.

These three measures were derived from observations coded on Matrix 1 while the following were from Matrix 2.

4. Praise of Child's Task Suggestions: Percent of child's Task Suggestions followed by maternal Praise.
5. Child's Impulse Control Efficiency: The percent of child's Impulse Control Statements followed by a Neutral response by the mother.

6. Independent Responding Interference: Percent of Child's Independent Responses followed by Maternal Direct Help.

Post-Interaction Questionnaire

Immediately following the Interaction session the mothers were given a questionnaire to complete in the presence of the experimenter. No mother was aware in advance that they would be asked to answer questions about the Interaction. The major purpose of the questionnaire was to examine whether the mothers' perceptions of the time they worked with their children would parallel the findings obtained from an objective analysis of the session. Consequently the questions they were asked were derived directly from the observational system. Mothers were also asked; (a) if there was anything that happened in the session that was not adequately covered in the questionnaire (Question 16), (b) if their child's behaviour in the laboratory was different from their behaviour at home (Question 17), (c) how often they worked together with their children at home (Question 18) and (d) to identify their educational expectations for their child (question 19). A complete copy of the questionnaire may be found in Appendix D. The answers to questions 16 and 17 were not analyzed statistically since no mother added information about the session not covered in responses to other questions and all said their children behaved no differently from the way they were at home when working on an interesting task.

Change in Child's Reflective-Impulsive Status

At the very end of the experimental session the children were administered a second form of the MFPT (Form S). As well as the total

error and mean latency scores observed a continuous variable DIF 2, formed in the same manner as the variable DIF 1, was used to examine the change in the child's status on the reflective-impulsive dimension.

Design and Statistical Analysis

The data sets obtained from the five major parts of the experimental session (Child Before, Mother Before, Interaction, Child After and Mother After) were analyzed separately. Each type of data within any one part was also analyzed separately, (eg. private speech, first trial response times, hypothesis-testing efficiency ...).

However, since most of these data types involved multiple dependent measures Multivariate Analyses of Variance followed by examination of significant univariate tests associated with obtained multivariate effects were frequently employed. This step was taken to minimize the number of erroneous conclusions due solely to correlated dependent measures (Hummel and Sligo, 1971). In analyses of Child Before data the between subject independent variables were Sex (male or female) and reflective-impulsive status (the continuous variable, DIF 1).

The only between subjects variable for the Mother Before data was reflective-impulsive status (the continuous variable, DIF M). Some types of data involved repeated measures, (eg. response times (problem number (1-8), feedback type (+ or -), trial position within block (1, 2, 3, 4 or F)); hypothesis testing efficiency (feedback type (+ or -)), scanning (problem number (1-8) or feedback type (+ or -)).

In these cases multivariate profile analysis was used (McCall and

Appelbaum, 1973). With this procedure inflated F values associated with violating the assumption of homogeneity of covariances (correlations) between repeated assessments are minimized yielding an exact solution slightly more conservative than conventional repeated designs when the assumption on the covariance relationships can be met. The profile analysis method involves multiplying the data by a set of independent contrasts (eg. orthogonal polynomials) representing the repeated factors and analyzing each factor in the design in a separate multivariate analysis. The between subject factors are analyzed then by using scores for each subject created by summing over all repeated factors in the design. It should be noted that it was only the threat of a possible violation of the covariance assumption that led to the use of this procedure. The problem solving strategy data could not be analyzed with these parametric designs since only group scores could be obtained. Thus separate Chi-Square tests were performed on this type of Before, After and Interaction data.

Similar designs were employed in the analysis of Interaction data but here a few more between subjects variables were employed. Specifically the reflective-impulsive status of the child (DIF1), the status of the mother (DIF M), the match between the mother and child tempos (i.e. mother impulsive - child impulsive; mother reflective - child reflective; mother impulsive - child reflective; mother reflective - child impulsive) and the sex of the child (male or female) were the variables under consideration. The continuous mother-child tempo match variable was only employed after it was discovered that the numbers of subject pairs in the four match conditions were

approximately equal (9, 10, 11, 10, respectively) the slight discrepancy was accounted for by the fact that 21 mothers had DIF M scores in the reflective direction and 19 mothers had scores in the impulsive direction.

The designs of the Child and Mother After Interaction data were exactly the same as those used in analyzing the Interaction data.

However, the data were standardized change scores. Standardized change in performance in the After sessions relative to the Before sessions were used because Kenney (1975) has indicated that this most adequately controls for a possible selection (reflective-impulsive groups) by treatment. (Interaction session) interaction. This interaction hypothesis predicts that individuals belonging to different populations are exposed to different environments which determine and maintain different levels of performance and different rates of growth. This implies that if raw change scores are analyzed then what is being tested is the difference in the rate of maturation between the groups rather than a true difference between them attributable to treatment effects. By standardizing change scores, differences in the variability of scores at first and second tests are stabilized. The change in the child's status on the reflective-impulsive dimension (DIF 2 - DIF 1) as a function of mother-child interaction patterns was examined using step-wise multiple regression.

Two important features of data analysis need to be discussed.

First, due to the fact that a relationship between MA, CA and reflective-impulsive status was observed for the children all analyses of data

involving the children was performed on residuals obtained after removing variability attributable to these two variables via multiple regression.

This precaution was taken even though no significant relationship was found between MA or CA and performance measures since the purpose of the study was to evaluate the role of reflective-impulsive status independently of these factors. The second feature needing clarification is the rationale behind a second set of analyses on the Before Interaction data not previously mentioned. Initially, it was not considered appropriate to use the mother's status on the dimension as an independent variable for Before analyses of the children's performance. The reason for this was simply that there appeared no direct precedent for expecting this variable among many other individual characteristics (eg. number of children in the family, birth position...) to play a significant role in accounting for variability in performance before mother and child had actually worked together on the experimental task. Moreover using only the child's reflective-impulsive status and sex allowed comparisons to be made between Child Before behaviour and previous studies where only children were used as subjects. However while examining the change in subjects' performance following the interaction session as a function of significant mother-child tempo match effects it became visually obvious that this tempo match variable could have played a role in accounting for Before Interaction variability. Thus both mother and child Before Interaction data was reanalyzed to examine this possibility. In the presentation of results to follow this second set of analyses will only be mentioned if a significant tempo match effect was obtained.

RESULTS

Results are outlined in the order they were defined in the preceding response measures section. Before, After and Interaction findings for a particular response type are presented together.

Problem Solving Behaviour

Blank Trials Consistency

No main or interaction effects were obtained in the extent to which subjects used H's consistently following positive or negative feedback. This finding was repeated in analyses of both Child and Mother Before, and Interaction data and did not change in subsequent alone session analyses. However all subjects (in all sessions) were more likely to use consistent hypotheses following positive feedback (mean proportion .94) than following negative feedback (mean proportion .85).

Hypothesis Testing Efficiency

Child Before Interaction. On first analysis the only significant multivariate test was due to feedback type (+ or -) ($F_{8,30} = 18.985$, $p < .001$). Irrespective of subject group all children were more likely to; a) change H's after negative feedback than repeat the same H following positive feedback ($F_{1,37} = 4.88$, $p < .032$), and b) code information more efficiently than recode it ($F_{1,37} = 48.07$, $p < .001$). The latter effect subsequently effected significantly better retention and intersection of coded information relative to recoded

information ($F_{1,37} = 36.20, p < .001$; $F_{1,37} = 9.58, p < .004$)

(Coding-Recoding Retention 1; Coding-Recoding-Retention-Intersection 1).

The only subject group difference obtained was revealed when the Child Before hypothesis testing efficiency data was examined using the match between mother and child's tempo as an independent variable. The only significant univariate test associated with the multivariate tempo match effect ($F_{24,70.2} = 1.72, p < .040$) was the proportion of H's logically consistent with information given on feedback trials one through three ($F_{3,31} = 2.91, p < .050$). This effect is depicted in the Before part of Figure 4. This shows the size of the subject's H set as a function of the size of the logically correct H set following negative feedback on the first, second and third feedback trials. It is the latter feedback trial, when there was only one logically correct H, that represents the significant effect obtained here. It can be seen from Figure 4 that impulsive children with impulsive mothers had a considerably larger H set (mean 12.05) relative to reflective children with impulsive mothers (mean 6.25) or reflective children with reflective mothers (mean 6.21) in the third block. The set size of impulsive children with reflective mothers (mean 7.25) was not significantly different from that of the other groups. Figure 4 also shows that the groups did not diverge gradually but rather suddenly at the third block.

Mother Before Interaction. As with the children the multivariate test of feedback type (+ or -) proved significant

($F_{8,31} = 29.701, p < .001$). However the univariate tests associated

Figure 4. Observed size of children's H set as a function of the logically correct size, whether the observations were obtained Before or After the Interaction session and the match between the child's and mother's tempo.

CHILD

BEFORE

AFTER

CHILD MOTHER

- Reflective - Reflective
- Impulsive - Impulsive
- ▲...▲ Impulsive - Reflective
- △--△ Reflective - Impulsive

Mean Observed Size of H Set

Size of Logically Correct H Set

with this effect were slightly different. Here the effect was not quite so pervasive. All mothers found coding easier than recoding ($F_{1,38} = 73.11, p < .001$) and retention over one block of coded material easier than recoded material ($F_{1,38} = 5.641, p < .021$) but there was no feedback effect in the measures involving intersection of information nor was there a difference in the win-stay, lose-shift probabilities. There was however, a difference in the performance of mothers as a function of their own reflective-impulsive status ($F_{8,31} = 2.24, p < .050$). The only univariate test associated with this effect was Coding-Recoding-Retention-Intersection 2 ($F_{1,38} = 4.82, p < .034$). This effect, represented in Figure 5, clearly showed that reflective mothers were more efficient at eliminating H's through the third block than impulsive mothers. The former group had an H set of 2.87 while the latter had one of 11.11 when the logical size of the set was only one H. Once again the figure indicates that the groups only diverged from one another at the final and presumably most difficult phase of the problems.

Interaction. Analysis of the hypothesis testing efficiency data obtained while mother and child worked together revealed a significant multivariate effect due to feedback type ($F_{8,29} = 18.067, p < .001$). Dyads were more likely to; a) repeat a positively reinforced hypothesis than to change an hypothesis receiving negative feedback ($F_{1,36} = 4.29, p < .043$), b) Code more effectively than recode information ($F_{1,36} = 39.72, p < .001$) and c) retain coded information better than recoded information over one block

Figure 5. Observed size of Mother Before H sets as a function of the logically correct size and the mother's status on the reflective-impulsive dimension.

MOTHER BEFORE

($F_{1,36} = 17.51$, $p < .001$). It should be noted that the tendency to use a win-stay strategy proportionately more often than a lose-shift approach here (a) above) is the reverse of what the Child Before analysis revealed. Only measures involving intersection of information were involved in further significant effects. The multivariate test of the child's reflective-impulsive status approached significance ($F_{6,31} = 2.232$, $p < .066$) and Coding-Recoding-Retention-Intersection 1 was associated with this effect ($F_{1,36} = 4.565$, $p < .037$). On second analysis the match between mother and child tempos also proved significant ($F_{24,70.2} = 1.990$, $p < .014$) with the Coding-Recoding-Retention-Intersection 2 variable associated with it ($F_{3,31} = 6.401$, $p < .002$). These two effects are depicted in Figure 6. When only two H's were logically correct dyads with reflective children had a mean H set size of 2.18 while dyads with impulsive children were using a mean of 3.59 H's.

Child Change After Interaction. Analysis of the children's change in performance in the After relative to the Before alone session revealed a significant effect due to the match in the reflective-impulsive status of mother and child. ($F_{8,30} = 2.413$, $p < .038$). While there were no differences between the four groups of children in the extent to which they adopted win-stay, lose-shift strategies Before Interaction, the four did change in different ways ($F_{1,37} = 6.512$, $p < .014$). As shown in Figure 7 reflective children who had interacted with their reflective mothers and impulsive children who had just finished working with their impulsive mothers both reduced their use of this

Figure 6. Observed size of Interaction H sets as a function of the logically correct size and the match between mother and child tempos.

4 2 1

Size of Logically Correct H Set

Figure 7. Children's use of win-stay, lose-shift strategy and the efficiency with which they retained coded and recoded information over two blocks of trials as a function of their own and their mother's reflective-impulsive status.

approach. Conversely reflective children of impulsive mothers did not change and impulsive children with reflective mothers increased their use of the win-stay, lose-shift strategy. This change resulted in After interaction proportions of children whose tempos matched their mothers (either both reflective or both impulsive) lower than similar proportions for mis-matched dyads.

A second univariate test associated with the multivariate tempo match effect was Coding-Recoding-Retention 2 ($F_{1,37} = 5.048$, $p < .029$) and is depicted in Figure 7 also. While the groups did not differ Before Interaction on this measure they did change differentially. While reflective children who had interacted with their reflective mothers increased the efficiency with which they retained material over two blocks of trials reflective children exposed to impulsive mothers decreased their retention effectiveness. The two groups of impulsive children (i.e. those with reflective or impulsive mothers) improved only slightly. The most demanding of the information intersection processes (Coding-Recoding-Retention-Intersection-2) was the third univariate test accompanying the tempo match effect ($F_{1,37} = 5.590$, $p < .026$). This is presented in the After portion of Figure 4. It can be seen that relative to their Before Interaction performance impulsive children of impulsive mothers decreased the size of their H set by the third block from 12.05 to 5.88, more improvement than any other group. However since reflective children with reflective mothers had done better initially their change from 6.21 to 1.88 H's left them the group who performed the best in the After alone session.

Impulsive children who had experienced working on the task with their reflective mothers also improved (i.e. from 7.25 to 3.62 H 's). The only group not improving were reflective children with impulsive mothers (from 6.25 to 6.54). The observed discrepancy in the ability of subjects to deal with information following positive versus negative feedback in the Child Before analysis did not change following the Interaction session.

Mother Change After Interaction. All mothers significantly improved their hypothesis testing efficiency in the After session relative to the Before Interaction session ($F_{8,31} = 5.632, p < .001$). All univariate tests associated with this effect were significant. There were no subject group differences in this change. Presumably reflective mothers irrespective of the tempo of their children still more accurately intersected information than impulsive mothers. Since there were no group differences related to the previously observed feedback type effect it must be concluded that retaining coded material was still easier than retaining recoded information for all subjects.

Problem Solving Strategies and Stereotypes

Examining problem solving strategies and stereotypes allowed a test of qualitative differences in performance not revealed by the quantitative hypothesis testing efficiency measures. While the three solution strategies may be ranked in order of their efficiency from focusing (Fo) through dimension-checking (D-Ch) to

hypothesis-checking (H-Ch) the three non-solution stereotypes (hypothesis-alternation (H-A) stimulus preference (S-P), random) are all equally inefficient.

Child Before Interaction. Fifty-six percent of the children's strategies were of the solution type. Of this 28 percent were D-Ch, 17 percent were H-Ch and 10 percent were Fo.

The 44 percent of stereotypic H sequences broke down to 25 percent S-P, 12 percent random and 7 percent H-A. The question asked in all analyses was whether the above distribution adequately characterized the performance of the various subject groups. The answer was no. Reflective children used proportionately more solution strategies than impulsives ($\chi^2_1 = 8.05, p < .01$). Taking this into account in determining expected values it was found that impulsive children with impulsive mothers used a significantly smaller proportion than expected of Fo and a larger proportion of H-Ch than expected ($\chi^2_6 = 24.92, p < .001$). Taking into account the fact that impulsives used more non-solution stereotypes than reflectives it was found that there were no subject group differences in the relative use of H-A, S-P and Random stereotypes. Figure 8 presents the distribution of the children's relative use of the various strategies and stereotypes as a function of the match between child and mother tempos.

Mother Before Interaction. Fifty-five percent of the mother's strategies were of the solution type. Of this 34 percent were D-Ch, 11 percent H-Ch and 8 percent Fo. The 45 percent stereotype sequences broke down to 23 percent S-P, 20 percent Random and 2 percent

Figure 8. Distribution of children's use of particular strategies and stereotypes as a function of the match between child and mother tempos.

CHILD

BEFORE

Percent

AFTER

CHANGE

Percent Change

Fo

D-Ch

H-Ch

H-A

S-P

Random

STRATEGY

CHILD
Reflective

MOTHER

Reflective - Impulsive

Impulsive - Reflective

Impulsive - Impulsive

H-A. This distribution did not represent all subject groups as reflective mother's used significantly more solution strategies than impulsives ($\chi^2_1 = 7.11, p < .005$). Even when this difference was taken into account in determining expected values it was found that reflectives used more F_0 than expected ($\chi^2_2 = 13.55, p < .01$). Within non-solution stereotypes it was found that impulsives used more S-P than expected ($\chi^2_2 = 11.35, p < .01$). These differences are depicted in the Before portion of Figure 9.

Interaction. During the Interaction session dyads used solution sequences 67 percent of the time and non-solution strategies 33 percent. This distribution only characterized the two tempo mismatched groups (i.e. reflective child with impulsive mother; impulsive child with reflective mother). Impulsive children with impulsive mothers used solution strategies only 51 percent of the time while 80 percent of reflective children with reflective mothers H sequences were of the solution type ($\chi^2_3 = 18.85, p < .001$). Over all strategies 34 percent were F_0 , 23 percent were D-Ch and 10 percent were H-Ch. Taking into account the fact that the four groups did not use solution strategies to the same extent it was found that reflective children with reflective mothers used more F_0 and D-Ch than expected while impulsive children with impulsive mothers used fewer F_0 and more H-Ch than expected ($\chi^2_6 = 45.33, p < .001$). Within non-solution strategies 13 percent were of the S-P type, 12 percent random and 8 percent were H-A. However this distribution was not representative

Figure 9. Distribution of mother's use of particular strategies and stereotypes as a function of the match between child and mother tempos.

MOTHER

- MOTHER CHILD
- Reflective - Reflective
 - Reflective - Impulsive
 - Impulsive - Reflective
 - Impulsive - Impulsive

as reflective children with reflective mothers used more H-A and less S-P than expected, impulsive children with reflective mothers used less H-A and more random than expected and impulsive children with impulsive mothers used less random than the total sample distributions would have predicted ($\chi^2_6 = 31.67$, $p < .001$). With respect to the reflective-impulsive status of mother-child pairs the distribution of H sequences over the six strategies and stereotypes is presented in Figure 10. A comparison of the Before parts of Figures 8 and 9 and this Interaction graph reveals that together mothers and children were more effective problem solvers than either were alone.

Child Change After Interaction. While before the interaction period it was reflective children who used solution strategies, after the interaction it was children who had worked with reflective mothers who were more efficient. That is, this change was brought about by a substantial decrease in the use of solution strategies by children with impulsive mothers and an even larger increase by impulsive children who had worked with reflective mothers ($\chi^2_3 = 29.14$, $p < .001$). The latter group principally demonstrated this change by a 27 percent increase in the use of D-Ch ($\chi^2_6 = 131.95$, $p < .001$). The greatest changes in performance within non-solution strategies were comparable decreases by all groups in S-P use and an increase by all in the use of random approaches. ($\chi^2_6 = 139.99$, $p < .001$). The latter effect presumably indicated an attempt by these children to use F_0 more often since the random category was most often invoked when children who were apparently using F_0 failed to intersect

Figure 10. Distribution of relative frequency with which
mother-child pairs used strategies and stereotypes
during Interaction.

INTERACTION

CHILD MOTHER

Reflective - Reflective

Reflective - Impulsive

Impulsive - Reflective

Impulsive - Impulsive

information when the third block feedback information was received. The above changes in performance and the absolute After Interaction performance level are depicted in Figure 8.

Mother Change After Interaction. While before interaction it was reflective mothers who used more solution strategies in the After session the situation changed so that mothers who were reflective or had interacted with reflective children used significantly more solution strategies than impulsive mothers who had just finished working with their impulsive children ($\chi^2_3 = 216.08$, $p < .001$). It can be seen from Figure 9 that while all groups but reflective mothers with impulsive children increased their use of F_0 this group was the only one to increase D-Ch. While impulsive mothers with impulsive children increased their use of F_0 this group decreased their use of both D-Ch and H-Ch resulting in an overall net loss in solution strategy usage ($\chi^2_6 = 147.91$, $p < .001$). The previous dominance of impulsive mothers in the use of the S-P non-solution stereotype was broken by impulsive mothers with reflective children who decreased their use of this stereotype by 39-percent. This left only impulsive mothers with impulsive children showing a high proportion of S-P H sequences ($\chi^2_6 = 70.72$, $p < .001$).

Scanning Behaviour

First Trial

Child Before Interaction. The only significant multivariate test in this analysis was due to problem number ($F_{6,32} = 5.186$, $p < .001$).

The proportion of fixations made to the subsequently chosen stimulus gradually increased linearly over the eight problems ($F_{1,37} = 9.892$, $p < .004$). Conversely irrespective of group subjects decreased the total number of fixations made on the first trial over the eight problems ($F_{1,37} = 28.836$, $p < .001$).

Mother Before Interaction. A similar problem effect was noted in the Before analysis of the mother's fixation data, ($F_{6,33} = 2.794$, $p < .026$). The total number of fixations decreased from 7.43 to 5.18 over the course of the eight problems ($F_{1,38} = 12.330$, $p < .002$). The proportion of fixations to the chosen stimulus increased significantly over the eight ($F_{1,38} = 5.957$, $p < .018$). The multivariate test of mother's reflective-impulsive status was also significant ($F_{2,37} = 4.249$, $p < .021$). Reflective mothers were observed to make an average of 6.72 fixations on the first trial while impulsive mothers fixated 4.76 times ($F_{1,38} = 8.583$, $p < .006$). The univariate test of the proportion of fixations to the chosen stimulus associated with this DIF M effect was not significant.

Child and Mother Change After Interaction. Neither of these analyses of change yielded significant effects.

Post-Feedback Interval

Child Before Interaction. A significant feedback type (+ or -) main effect ($F_{2,37} = 54.148$, $p < .001$) was clarified by two interactions. The univariate test of the proportion of fixations directed toward the correct stimulus in the 3-second post-feedback

interval ($F_{1,38} = 10.725, p < .003$) was associated with the multivariate test of the feedback type by DIF 1 interaction. The mean total number of fixations following feedback measure ($F_{1,38} = 8.727, p < .006$) was associated with the multivariate feedback type by DIF 1 by sex interaction ($F_{2,35} = 5.568, p < .008$). The latter two effects are depicted in Figure 11. Reflective children used a greater proportion of their fixations on the correct stimulus following positive feedback relative to the proportion they made following negative feedback. This discrepancy was not significant for impulsive children.

Looking at the total number of fixations measure it was found that females (irrespective of tempo) as well as reflective males fixated more following negative feedback than positive feedback. This effect was not significant for impulsive males.

Mother Before Interaction. As with the children a significant feedback type effect was obtained ($F_{2,37} = 84.002, p < .001$). Mothers fixated on the correct stimulus a greater proportion of times following positive feedback (.78) than following negative feedback (.49) ($F_{1,38} = 138.803, p < .001$). However mothers made more total fixations following negative (2.16) as opposed to positive (1.45) feedback ($F_{1,38} = 57.50, p < .001$).

Child Change After Interaction. The observed discrepancy in the number of fixations made following negative vs. positive feedback in the Before analysis was significantly reduced by the children in the After Interaction session ($F_{2,37} = 6.410, p < .005$). However

Figure 11. Proportion of fixations directed toward the correct stimulus in the 3-second interval following positive or negative feedback as a function of the reflective-impulsive status of children in the Before Interaction Session.

CHILD BEFORE

Feedback Type

this reduction was not representative of all subject groups as evidenced by an interaction in the analysis of change between feedback type, reflective-impulsive status and sex ($F_{2,35} = 3.817$, $p < .031$) for the total number of fixations measure ($F_{1,36} = 6.304$, $p < .016$).

Figure 12 shows this effect. Interestingly, this interaction resulted in the previously observed discrepancy between the number of fixations made following positive vs. negative feedback to be confined to reflective subjects only. That is, ~~impulsive females~~ joined their male counterparts in not making a significantly different number of fixations as a result of differential feedback. Only reflectives showed this discrepancy now. Since there was no change attributable to the proportion of fixations directed toward the correct stimulus it may be assumed that reflectives in the After Interaction period maintained their tendency to fixate to the correct stimulus proportionately more often following positive feedback than negative and that impulsives continued not to distinguish feedback types in this way.

Mother Change After Interaction. There was no significant change in mother's scanning behaviour. That is, all mother's maintained the previously discussed discrepancy in fixations following positive vs. negative feedback.

Response Times

First Trial

Child Before Interaction. Only the reflective-impulsive status of the child even approached significance ($F_{1,36} = 2.961$, $p < .090$).

Figure 12. Total number of fixations in the 3-second interval following positive or negative feedback as a function of the sex and reflective-impulsive status of children.

CHILD

BEFORE

AFTER

CHANGE

Reflectives on average took 3.92 seconds before responding while impulsives took 2.93 seconds.

Mother Before Interaction. Reflective mothers had significantly longer response times (mean 8.92 seconds) than impulsive mothers (mean 5.71 seconds) ($F_{1,38} = 8.647, p < .006$). The main effect for problem number was also significant ($F_{3,37} = 4.154, p < .012$). Only the cubic univariate test was associated with this ($F_{1,38} = 6.127, p < .017$). This was due to the fact that response times on the first trial of the two problems immediately following ones characterized by an all negative feedback sequence (i.e. -, -, -) were higher than those following any other feedback sequence.

Mother and Child Change After Interaction. There were no significant changes in first trial response times.

Feedback Type

Child Before Interaction. A significant feedback type effect indicated that all subjects responded more slowly on trials following negative feedback (mean 2.30 seconds) than on trials after positive feedback (mean 1.84 seconds) ($F_{1,38} = 34.17, p < .001$). A significant trial position effect ($F_{4,35} = 17.49, p < .001$) was associated with linear ($F_{1,38} = 13.29, p < .001$) and quadratic ($F_{1,38} = 12.56, p < .001$) univariate tests. That is while response times tended to decrease over the five trials within a block they also increased at the end of the block presumably in anticipation of the next feedback trial.

Mother Before Interaction. Reflective mothers took longer to respond than impulsive mothers ($F_{1,38} = 7.898, p < .008$). Significant feedback type ($F_{1,38} = 30.892, p < .001$) and Trial position ($F_{4,35} = 27.017, p < .001$) main effects were clarified by a feedback type by trial position interaction ($F_{4,35} = 3.824, p < .011$). Following negative feedback response times decreased quickly over the remaining trials in the block. After positive feedback all response times were equally low across all trial positions. This interaction and the DIF M main effect is depicted in Figure 13.

Interaction. Significant tempo match ($F_{3,32} = 3.816, p < .019$) and feedback type ($F_{1,37} = 15.246, p < .001$) main effects were elucidated by a match by feedback type interaction ($F_{1,37} = 10.096, p < .003$) presented in Figure 14. Following negative feedback reflective mothers and their children had longer response times than impulsive mothers and their children. However, following positive feedback only reflective mothers with reflective children maintained high response times while all other mother-child pairs, including reflective mothers with impulsive children, had lower response times.

Child and Mother Change After Interaction. No changes in the response times of mothers or children proved significant.

Feedback Sequence

It should be noted that for analysis purposes the four possible feedback sequences were ordered according to two simultaneous criteria; a) according to the number of negative feedback trials and

Figure 13. Mother Before Interaction response times as a function of reflective-impulsive status, feedback type and trial position within block.

MOTHER BEFORE

Figure 14. Response times during the Interaction session
as a function of mother-child tempo match
and feedback type.

INTERACTION

CHILD MOTHER

Reflective - Reflective
 Reflective - Impulsive
 Impulsive - Reflective
 Impulsive - Impulsive

Mean Response Time (seconds)

5 4 3 2 1 0

+

Feedback Type

-

b) according to the number of consecutive negative feedback trials (i.e. ++, - +, + -, - -) .

Child Before Interaction. The feedback sequence ($F_{3,36} = 5.673$, $p < .003$) and trial position ($F_{4,35} = 4.835$, $p < .004$) main effects were both significant. As with the feedback type analysis subject's response times were longest immediately after and just before feedback (trial position quadratic, $F_{1,38} = 18.993$, $p < .001$). The linear ($F_{1,38} = 5.095$, $p < .028$), quadratic ($F_{1,38} = 5.692$, $p < .021$) and cubic ($F_{1,38} = 10.008$, $p < .004$) tests associated with the feedback sequence effect were all significant. Subjects responded most slowly following the - , + sequence (2.786 seconds). The sex of the child was also a factor approaching significance ($F_{1,38} = 3.72$, $p < .058$). Males tended to respond more slowly than females. The above three main effects are presented together in Figure 15.

Mother Before Interaction. Reflective mothers responded more slowly than impulsive mothers during the third block ($F_{1,38} = 14.96$, $p < .001$) as was consistent with the feedback type and first trial response time analysis. Both the linear ($F_{1,39} = 25.27$, $p < .001$) and quadratic ($F_{1,39} = 40.16$, $p < .001$) tests of the trial position effect ($F_{4,36} = 10.57$, $p < .001$) were significant. Mothers decreased their response times over the third block but also showed a consistent rise on the trial immediately preceding the last feedback. The feedback sequence main effect while only marginally significant ($F_{3,37} = 2.64$, $p < .063$) was associated with a highly significant cubic effect ($F_{1,39} = 6.06$, $p < .017$). These three main effects have been drawn together in Figure 16.

Figure 15. Child Before Interaction third block response times as a function of feedback sequence, trial position and sex of the child.

CHILD BEFORE

Male ●—
Female ○---

Mean Response Time (Seconds)

1 2 3 4 F 1 2 3 4 F 1 2 3 4 F 1 2 3 4 F

++ + -
Feedback Sequence

Figure 16. Mother Before Interaction third block response times as a function of feedback sequence, trial position and the reflective-impulsive status of the mother.

MOTHER BEFORE

Mean Response Time (seconds)

Reflective ●
Impulsive ○

1 2 3 4 F 1 2 3 4 F 1 2 3 4 F 1 2 3 4 F

Feedback Sequence
+ + - + - -

Interaction. As before, the linear ($F_{1,38} = 8.554$, $p < .006$) and quadratic ($F_{1,38} = 13.403$) tests were associated with the trial position effect ($F_{4,35} = 3.232$, $p < .023$). The only other significant effect in this analysis was the feedback sequence by trial position by mother-child tempo match interaction ($F_{12,26} = 2.987$, $p < .010$). This interaction is presented in Figure 17. After receiving three negative feedbacks in a row children with their reflective mothers responded dramatically slower than children with impulsive mothers. Following any other feedback sequence the differences are less clear-cut as reflective children with reflective mothers maintain long response times relative to impulsive children with impulsive mothers but the two mis-matched tempo groups (reflective children with impulsive mothers and impulsive children with reflective mothers) tended to jump between these two extremes.

Child Change After Interaction. The only significant change was attributable to the feedback sequence effect ($F_{3,36} = 7.720$, $p < .001$). While response times went up, down and then up again as the number of consecutive negative feedback trials increased Before Interaction, this changed to produce a linear increase in response times from a low of 1.844 seconds following the + , + sequence to a high of 2.57 seconds following the - , - sequence.

Mother Change After Interaction. There were no changes in maternal third block response times following interaction. Reflective mothers maintained higher response times than impulsive mothers.

Figure 17. Interaction third block response times as a function of feedback sequence trial position and the mother-child, reflective-impulsive match.

INTERACTION

CHILD MOTHER

- Reflective - Reflective
- Impulsive - Impulsive
- ▲---▲ Impulsive - Reflective
- △---△ Reflective - Impulsive

Mean Response Time (seconds)

1 2 3 4 F 1 2 3 4 F 1 2 3 4 F 1 2 3 4 F
 + + + +
 Feedback Sequence

Private Speech

Child Before Interaction. Only on second analysis using the match between mother and child tempos as a variable was a significant multivariate effect obtained. The tempo match effect ($F_{39,59.97} = 2.799, p < .001$) was associated with the feedback speech ($F_{3,32} = 9.778, p < .001$) and the total amount of private speech ($F_{3,32} = 3.259, p < .034$) variables. Children whose tempos matched those of their mothers (child impulsive - mother impulsive; child reflective - mother reflective) used less feedback speech than those whose tempos did not match their mothers (child impulsive - mother reflective; child reflective - mother impulsive). The Before section of Figure 18 shows this effect. However, children with reflective mothers regardless of their own reflective-impulsive status used more private speech than children with impulsive mothers. This effect is shown in Figure 19. Canonical correlation analysis of the relationship between private speech usage and hypothesis testing efficiency yielded no significant canonical variates.

Mother Before Interaction. There were no significant group differences in the mothers' use of private speech. However, since it was not expected that the mothers would use much private speech at all a comparison was made between the speech of the mothers and that of their children using age (adult mother vs. child) as a variable along with the sex of the child and the reflective-impulsive status of both mother and child. It was found that the 'age' effect ($F_{12,27} = 2.11, p < .050$) indicated mothers used less reinforcement speech,

Figure 18. Children's use of feedback private speech as a function of the match between mother and child tempos.

FEEDBACK SPEECH

Figure 19. The total amount of private speech used by children as a function of the match between mother and child tempos.

NUMBER OF UTTERANCES

($F_{1,38} = 7.237, p < .010$) and fewer remarks addressed to non-human objects ($F_{1,38} = 5.589, p < .036$) than their children. The surprising thing about this analysis would seem to be the relatively few differences between these two groups. The children made a total of 48 classifiable utterances while the mothers for the same period made 53.

Child Change After Interaction. Irrespective of subject group there was an overall change in private speech After Interaction ($F_{13,26} = 2.575, p < .019$). The children increased the amount of private speech they used ($F_{1,38} = 4.253, p < .044$) from 38 to 58 utterances. Further they; a) increased their use of word play ($F_{1,38} = 6.122, p < .017$), b) increased the amount of self-guiding speech ($F_{1,38} = 13.760, p < .001$), c) increased their use of conclusions ($F_{1,38} = 9.056, p < .005$) and d) decreased the proportion of inaudible lip movements ($F_{1,38} = 14.199, p < .005$). These changes are shown in Figure 20. There were group differences in private speech change as well. A sex by child's reflective-impulsive status ($F_{13,24} = 2.360, p < .033$) interaction was linked to the univariate test of the emotional expressions variable ($F_{1,36} = 16.281, p < .001$). Figure 21 shows this interaction. Inspection of this figure reveals that the Before Interaction analysis might have indicated a DIF 1 by sex interaction for emotional expressions. This was in fact true ($F_{1,36} = 6.17, p < .017$) but the multivariate Before test was not significant. In any case, After Interaction the children changed so that reflective females and impulsive males

Figure 20. Children's use of private speech Before
and After Interaction.

CHILD

Mean Percent of Total Speech

Before Interaction
After Interaction

1 2 3 4 5 6 7 8 9 10 11 12

Private Speech Category

Figure 21. Children's use of the private speech category
emotional expressions as a function of their
reflective-impulsive status and sex.

EMOTIONAL EXPRESSIONS

made fewer emotional expressions than the other groups. A mother-child tempo match effect was also obtained ($F_{13,25} = 2.844, p < .012$), indicating significant changes in feedback speech ($F_{1,37} = 7.148, p < .011$) and the total amount of private speech the children used ($F_{1,37} = 4.881, p < .031$). These effects have already been presented in Figures 18 and 19 respectively. While before interaction it was children with reflective mothers who said the most, this changed following interaction so that only reflective children with reflective mothers said more than any other group. With respect to feedback speech the previous superiority of children whose tempos did not match their mothers was changed so that children who had impulsive mothers regardless of their own tempo were now showing the most feedback speech.

Mother Change After Interaction. The mothers use of private speech did not change following the Interaction session. This stability in performance on this unexpected measure is depicted in Figure 22.

Mother-Child Interaction Patterns

Preliminary analysis comparing the frequency with which mothers and children used the behaviour categories as antecedents as opposed to the frequency they used them as consequents revealed considerable differences (mothers - $F_{9,31} = 13.152, p < .001$; children - $F_{9,31} = 11.345, p < .001$). The behaviour categories

Figure 22. Mother's use of private speech Before and
After Interaction.

- Key: 1. Describing own activity
2. Remarks addressed to non-human objects
 3. Self-commands
 4. Self-questions
 5. Word play
 6. Feedback speech
 7. Incomprehensible speech
 8. Emotional expressions
 9. Self-guiding comments
 10. Conclusions
 11. Neutral
 12. Inaudible muttering

3 3
OF/DE

MOTHER

showing this difference for mothers and children are indicated in Tables 12 and 13, respectively.

Mother Antecedent - Child Consequent (Matrix 1)

Reflective mothers gave more Indirect Help to their children (7.4 percent) than impulsive mothers (4.8 percent) ($F_{1,37} = 7.107$, $p < .011$) and were less likely to have their behaviour classified in the No Response category (16.76 percent) than impulsive mothers (23.26 percent) ($F_{1,37} = 6.891$, $p < .012$). Mothers were also more likely to praise their sons (8.6 percent) than their daughters (4.0 percent) ($F_{1,37} = 18.712$, $p < .001$) and to direct more Impulse Control statements to their tempo matched sons and mismatched daughters (7.78 percent) than their matched daughters and mismatched sons (4.78 percent) ($F_{1,36} = 6.890$, $p < .012$).

In response to their reflective mothers, regardless of their own reflective-impulsive status, children made more Task Suggestions (17.34 percent) than when responding to their impulsive mothers (12.42 percent) ($F_{1,37} = 7.263$, $p < .010$). The only other difference in child consequent behaviours was that sons were more likely to respond to their mothers' questions (86.02 percent) than were daughters (69.34 percent) ($F_{1,38} = 4.566$, $p < .038$).

Child Antecedent - Mother Consequent (Matrix 2)

Children whose tempos matched their mothers' (both mother and child reflective or both impulsive) responded Independently more often (15.05 percent) than children whose tempos did not match their mothers'.

Table 12

Mother's percent use of Behaviour Categories as Antecedent
and Consequent Responses

	Mother	
	Antecedent	Consequent
Question	7.56	9.45
Praise	6.30	* 8.85
Neutral	12.26	*** 5.05
Indirect help	6.10	*** 16.50
Negative	4.40	5.25
Direct Help	26.10	*** 15.95
Conclusion	11.70	*** 4.05
Impulse Control	6.10	* 3.70
No Response	19.85	** 29.15

* $p < .05$

** $p < .01$

*** $p < .001$

Table 13

Child's percent use of Behaviour Categories as Antecedent
and Consequent Responses

	Antecedent	Child	Consequent
Compliance	7.85	***	17.55
Independent Responding	12.75		15.80
Task Suggestion	24.00	***	15.00
Conclusion	10.86		8.35
Impulse Control	5.60	**	2.40
Negative	5.45		4.80
Interaction	19.10		18.45
Comments	2.20	*	1.15
No Response	10.20	***	17.06

* $p < .05$

** $p < .01$

*** $p < .001$

(10.67 percent) ($F_{1,37} = 4.594, p < .037$). The children whose mothers made the most Impulse Control statements were the ones that volunteered the most Conclusions, ($F_{1,36} = 6.716, p < .013$). That is, tempo matched sons and mismatched daughters made statements about the probable problem solution more frequently (14.52 percent) than tempo matched daughters and mismatched sons (8.14 percent). However, it was also found that impulsive children were more likely to make Conclusions (12.90 percent) than reflective children (8.80 percent) ($F_{1,37} = 3.947, p < .052$). Thus male impulsives with impulsive mothers made the most conclusions (20.50 percent) while female reflectives with reflective mothers made the least number of Conclusions (6.33 percent).

Mothers of reflective children made more Conclusions (5.00 percent) than mothers of impulsive children (3.10 percent) ($F_{1,37} = 4.725, p < .034$). Presumably mothers responded with Conclusions when their children made few and vice versa, apparently balancing out the total number of Conclusions made by the pairs as units. While there were no group differences with respect to the number of Impulse Control statements made to the mother by the child, there was a difference in the extent to which the mothers complied with these attempts at controlling her behaviour ($F_{1,36} = 8.136, p < .007$). Mothers were most likely to comply if their child was an impulsive son (62.50 percent compliance) and least likely to comply if their child was a reflective son (25.99 percent). Paralleling the antecedent analysis mothers praised sons more often (11.00 percent) than daughters (6.70 percent) ($F_{1,37} = 6.142, p < .017$).

Post Interaction Questionnaire

Since the majority of the questions asked of the mothers immediately following the Interaction session corresponded to behaviour categories in the observational schedule, the results of the questionnaire analysis will be presented with reference to the preceding findings.

In general, the mothers' perceptions of the session were quite different from what was observed. For example, while there were no group

differences in the analysis of the extent to which mother's interrupted their children when they were working independently, mothers of

impulsive children reported that they interrupted more frequently

than mothers of reflective children ($F_{1,37} = 5.249, p < .026$). Further,

in the analysis of observational data it was found that mothers with

sons praised more often than mothers with daughters. Conversely, the

mothers of reflective sons or impulsive daughters reported they showed more approval following compliance than mothers of reflective daughters

or impulsive sons, ($F_{1,36} = 8.274, p < .007$). There were no group

differences observed in the extent to which children complied to specific maternal suggestions. However, mothers reported differences. Impulsive

mothers reported that their impulsive sons almost never complied to

their task suggestions while mothers whose daughters' tempo matched

their own said their children almost always complied ($F_{1,36} = 4.768, p < .034$).

These last two effects have been depicted in Figure 23. In

a comparison between observed and reported lack of interest in the

task, it was found that while impulsive mothers were observed to use

the No Response category more often than reflective mothers, the mothers

Figure 23. Mother's response to Questionnaire on
Interaction Session.

"When your child did something you asked, did you show your approval (verbally or nonverbally)?"

☒ Reflective
☐ Impulsive

Always 7

6

5

Sometimes 4

3

2

Never 1

Male

Female

"Did your child accept and act upon your specific suggestions re: solving the problem?"

CHILD MOTHER
☒ Reflective - Reflective
☒ Reflective - Impulsive
☒ Impulsive - Reflective
☐ Impulsive - Impulsive

Male

Female

with daughters reported that their interest lagged more often than mothers of sons ($F_{1,38} = 5.538, p < .023$). The apparent greater interest in sons may be the reason for the observed higher degree of praise given to sons. While there were other behaviour categories on which subject groups were observed to differ there were no further differences in the mothers' reports of the Interaction session.

At the end of the questionnaire the mothers were asked to estimate how often they worked with their child at home. There were no group differences in the answers either to this question or to a question about the mothers educational expectations for their children. However, 35 percent of reflective mothers initially refused to answer the educational expectations questions. All of these mothers said that their own expectations were irrelevant since their children would make decisions for themselves. No impulsive mother said she was reluctant to answer the question.

Change in Child's Reflective-Impulsive Status

At the end of the experimental session, the children were given a second form of the MFPT (Form S). As a result, the 'equivalence' of the two elementary MFPT forms must be placed in doubt. Both errors and particularly response times increased significantly over the two forms. The second form was obviously more difficult than the first. However correlations between the standardized composite reflection-impulsivity scores (DIF 1 and DIF 2) were highly significant for both

males and females. For males the first test's latency scores were most related to both errors and latency scores on the second test while for females it was the first test's error scores that were most highly related to performance on the second test. The relationship between MA, CA and MFFT performance was maintained on the second test for males. For girls only MA and errors were related. On the first test only the correlation between mother's response times and the error scores of their daughters even approached significance. On the second test, mothers error scores were negatively related to sons response times while the mothers response times were positively related to daughters response times. These correlations are presented in Table 14.

An analysis of change in the children's standardized reflective-impulsive status revealed that initially impulsive children changed the most and in the reflective direction ($F_{1,37} = 22.83, p < .001$). The reflective-impulsive status of the mother approached significance as a factor accounting for variability in the change in the child's tempo ($F_{1,37} = 3.34, p < .07$). Children with reflective mothers tended to be more reflective on second test.

In order to determine if mother-child interaction patterns could predict which impulsive children would become more reflective on the second MFFT, the change in the child's tempo score was analyzed as a function of mother-child interaction patterns. At the point in stepwise multiple regression where a maximum of variability in the

Table 14

Pearson Correlations between the Child's Before and After Interaction MFPT performance (Forms F and S, respectively) and the mother's MFPT performance (Adult Form), the child's MA, CA, IQ and sex.

	Errors 2 Mean 12.63 SD 5.68		Latency 2 Mean 19.78 SD 13.18		DIF 2 Mean 0.0 SD 1.83	
	Males	Females	Males	Females	Males	Females
CA						
Mean 8.76	.70***	-.32	.43*	.32	-.63***	-.35
SD .59						
MA						
Mean 10.45	-.65***	-.47*	.39*	.36	-.58**	-.45*
SD 1.36						
IQ						
Mean 114.32	-.26	-.29	.14	.18	-.23	-.25
SD 10.40						
Errors 1						
Mean 8.82	.29	.66***	-.48*	-.65***	.41*	.72***
SD 5.55						
Latency 1						
Mean 13.26	-.42*	-.38*	.68***	.50*	-.58**	-.48*
SD 8.17						
DIF 1						
Mean 0.09	.38*	.56**	-.63**	-.62**	.54**	.65***
SD 2.24						
Mother Errors						
Mean 8.57	.33	.15	-.41*	-.22	.40*	-.20
SD 5.71						
Mother Latency						
Mean 54.70	-.09	-.24	.20	.54**	-.26	-.43*
SD 24.94						
DIF M						
Mean 0.00	.23	.22	-.33	-.43*	.30	.36
SD 1.81						

* $p < .05$

** $p < .01$

*** $p < .001$

change in reflective-impulsive status variable was accounted for by the fewest number of Matrix 1 mother-child interaction variables, the regression equation accounted for 50 percent of the change ($F_{11,28} = 2.547, p < .05$). The impulsive children who changed most in the reflective direction were those whose mothers had; a) given the least Indirect Help ($F_{1,28} = 13.143, p < .01$) and b) been most involved in the task ($F_{1,28} = 6.177, p < .05$). In response to their mothers, children who became more reflective a) answered more questions ($F_{1,28} = 7.895, p < .01$), b) were more involved in the task ($F_{1,28} = 6.659, p < .05$), c) used more Negative responses ($F_{1,28} = 4.980, p < .05$), and d) directed more Impulse Control statements to the mother ($F_{1,28} = 4.732, p < .05$).

At the point in stepwise multiple regression where a maximum of variability in the change in reflective-impulsive status of the children was accounted for by Matrix 2 mother-child interaction variables, the regression equation accounted for 57.7 percent of the variance ($F_{10,29} = 3.963, p < .01$). Children who changed their status most in the reflective direction used as antecedents; a) more Negatives ($F_{1,29} = 13.827, p < .01$), and b) fewer Comments ($F_{1,29} = 4.201, p < .05$). In this same equation children who became more reflective had mothers who responded to them with a) more Questions ($F_{1,29} = 4.790, p < .05$), b) fewer Negatives ($F_{1,29} = 7.229, p < .05$), c) more Impulse Control statements ($F_{1,29} = 9.752, p < .01$), and d) fewer Conclusions ($F_{1,29} = 4.840, p < .05$).

DISCUSSION

The purpose of the present study was to examine some characteristics and potential determinants of reflective and impulsive behaviour. To achieve the first of these goals the results of the analysis of Before Interaction response measures will be discussed in relation to hypotheses derived in the review of previous studies presented in the Introduction. Potential determinants of reflective and impulsive behaviour will then be discussed in the context of obtained differences in mother-child interaction patterns and subsequent changes in performance following interaction.

Characteristics of Reflective and Impulsive Behaviour

It was expected that reflectives would be more effective at solving problems than impulsives (Ault, 1973; Denney, 1973a; McKinney, 1973; Nuessele, 1972; Stein and Prindaville, 1976). This expectation was essentially confirmed. Reflective mothers were more efficient focusers than impulsive mothers. With the children however, only when the tempo of both mother and child was taken into account were significant group differences obtained. Impulsive children with impulsive mothers were significantly less effective at intersecting coded, recoded and retained information than reflective children. Examination of the relative efficiency with which subjects used the component processes necessary for effective problem solving indicated that the only distinguishing feature of reflective and impulsive behaviour for both

mothers and children was the process of intersecting information (i.e. the ability to intersect the overlap of previous and current sets of logically correct H's to obtain the solution set). The analysis of strategies and stereotypes supported McKinney's (1973) finding that impulsives use more hypothesis-checking than reflectives. In this study this effect was confined to impulsive children with impulsive mothers.

Since Drake (1970) obtained group differences in analyses of scanning behaviour in the first six seconds of a problem which were not confirmed in overall analyses, fixations on the first trial of each problem were analyzed separately from the post-feedback scanning data. The fact that no group differences were obtained in the proportion of fixations directed toward the chosen alternative on the first trial with either mothers or children would seem to contradict Drake's (1970) and Wright's (1971) findings while confirming the Zelniker et al (1972) result. Reflective mothers did make more total fixations to stimuli on the first trial than impulsive mothers however. This difference adds more weight to the argument in favour of using proportional or fixed time interval scanning measures than it adds to the growing list of reflective-impulsive behaviour differences: mothers showed a similar reflective-impulsive difference in first-trial response times.

Analysis of scanning behaviour in the fixed three second interval following feedback proved more fruitful as only reflective

children shared with ~~the~~ mothers a tendency to fixate the correct stimulus more often following positive than negative feedback. This would imply that impulsive children do not use their scanning behaviour as an aid in dealing with feedback information. They do not distinguish relevant and irrelevant information in this way. This finding would seem consistent with the contention that the performance of reflective children is characterized by detailed visual feature analysis while the performance of impulsive children is characteristically more global in nature (Hallahan, Kauffman and Ball, 1973; Kilburg and Siegel, 1973; Odom, McIntyre and Neale, 1971; Zelniker and Oppenheimer, 1973, 1976; Zelniker and Jeffrey, 1976). The fact that both impulsive and reflective mothers showed this feedback discrepancy, however, would indicate that this reflective-impulsive processing difference must be confined to children.

Analysis of response times as a function of feedback type or feedback sequence provided a test of the hypothesis that reflectives and impulsives respond differently following success and failure. Paralleling the findings of Messer (1970) and Weiner and Adams (1974) but contradicting those of Ward (1968b), both mothers and children regardless of tempo status, showed higher response times following negative as opposed to positive feedback. However, it is possible that the required three second wait following feedback obviated any subsequent group differences. The fact that following negative feedback impulsives

looked at the stimuli less than any other group during this interval provides support for this possibility. While there was no tempo by feedback type interaction in the analysis of response times, reflective mothers did respond more slowly overall than impulsive mothers. With the children, the only comparable difference was found in first trial response times. Differences like these have provided a rationale for the use of required delay as a training strategy when attempting to modify tempos. (Briggs and Weinberg, 1973; Denney, 1973a; Kagan et al 1966). However the observed differences in the scanning behaviour of reflectives and impulsives indicate that increased time alone is not a sufficient condition for producing reflectivity.

In the analysis of childrens private speech before the interaction session, the tempo of both mother and child played a significant role. Children whose tempos matched those of their mothers talked less about feedback than children whose tempos did not match those of their mothers. Further, children with reflective mothers used more private speech than children with impulsive mothers, regardless of their own tempo status. While no specific predictions were made concerning the childrens' use of private speech, it was expected that there would be a relationship between private speech use and problem solving behaviour. The fact that no such relationship was obtained places the use of verbal self-control training as a tempo modification technique in considerable doubt. For example, not only

did reflective and impulsive children not differ in the extent to which they used self-guiding speech, the use of this category of private speech was unrelated to problem solving effectiveness.

It was not expected that mothers would use private speech to any extent, since previous studies had indicated that this form of speech is gradually internalized with age (Beaudichon, 1973; Klein, 1963, Kohlberg et al, 1968). The distinguishing feature of this study, however, was that observations were made while subjects were performing a relatively difficult task. The finding that the quality of the mother's speech differed from that of her child's very little would suggest that private speech during problem solving does not show the same kind of developmental trend previously observed.

Determinants of Reflective and Impulsive Behaviour

The most pervasive effect obtained in this study provides strong evidence for the role of mothers in determining the reflective-impulsive status of their children. Not only was the tempo of both mother and child an important factor accounting for differences in interaction patterns, but this match in tempos was also an important variable in determining the extent of subsequent changes in performance. Moreover, the fact that the reflective-impulsive status of both mothers and children played a significant role in analyses of the child's behaviour, even before mother and child had had a chance to influence one another, provides support for the generality and importance

of this conclusion. In answering the question of how the match between mother and child tempos determines behaviour the results of the analysis of mother-child interaction patterns will be discussed and followed by an examination of changes in performance brought about by this interaction.

Mother-Child Interaction Patterns

The necessity of examining interaction patterns in such a way as to allow estimation of both antecedent and consequent stimulus control has been demonstrated. Mothers and children were different when responding to interaction initiated by the other member of the dyad (consequent behaviour) than they were when they themselves initiated contact (antecedent behaviour). This distinction would be less important in the present context, perhaps, if the interaction patterns of reflective and impulsive mothers and children had revealed that the antecedent behaviours distinguishing subject groups were the same as the consequent behaviour categories differentiating them. For example, reflective mothers used more indirect help as an antecedent to their child's response more often than impulsive mothers. But there were no differences in the use of this behaviour category by reflective and impulsive mothers when responding to their children. This type of result would indicate that the majority of previous studies of mother-child interaction may have failed to notice reliable differences in interaction patterns because they did not distinguish antecedent and consequent behaviour.

Campbell's (1973) study was the only previous one that had looked at interaction patterns as a function of reflective-impulsive status. The only consistency between that study and the present study was that both found mothers of reflective children made more conclusions about task solution than mothers of impulsive children. All other observed differences in interaction patterns in the current study were related to a) the match between mother and child tempos and/or b) the sex of the child and/or c) whether behaviour served as an antecedent or consequent. Thus further comparison between the two studies is difficult since Campbell observed only mother-son interactions, did not take into account the mother's status on the reflective-impulsive dimension, and finally, did not systematically distinguish antecedents and consequents.

The numerous differences in interaction patterns attributable to sex differences, or sex by tempo match interactions, deserve comment. More praise was given to sons than to daughters, and sons were more likely to answer questions than daughters. Further, sons whose tempo matched and daughters whose tempo did not match their mothers, were more likely to receive impulse control statements and to make more conclusions about problem solutions. These differences and subsequent sex differences in the behaviour change of the children clearly indicate that mothers and sons have a different relationship than mothers and daughters. Further study may reveal that comparable, but reversed, sex and tempo-match relationships exist between fathers and sons and fathers and daughters. The tempo of the father also seems the most plausible reason why some children's tempos matched their mother's,

while other children's did not. This interpretation would predict that children whose parents' tempos do not match (eg. father reflective - mother impulsive or father impulsive - mother reflective) are the same children whose tempos are unlikely to match their mothers. This hypothesis is indirectly supported by the fact that the overall correlation between the reflective-impulsive status of children and mother is frequently not a significant one. Why children with mismatched parents should be more like one than the other is not understood. It could be attributable to the relative amounts of time the mother and father spend with the child, and/or, due to some predisposition of the child's.

The behaviour categories of impulse control, direct help and indirect help used in this study were all related to previous methods used to try and modify tempos experimentally. That is, the impulse control category was most like required delay techniques, while direct help more closely approximated the modelling studies and indirect help related to the scanning and strategy instruction methods. As indicated in the Introduction the most effective technique has been the scanning and strategy instruction method. The finding that reflective mothers used this approach more frequently than impulsive mothers, together with the result that reflective mothers were more likely to have their impulsive children show the most change in the reflective direction, would tend to support the notion that strategy instruction is an effective method of modifying cognitive tempos. However, the direct analysis of the relationship between mother-child interaction patterns

and subsequent change in reflective-impulsive status, contradicts this conclusion. Paradoxically, the children who changed the most had mothers who responded to them with the most impulse control statements during the interaction. In conjunction with the above findings, this suggests perhaps, that mothers do different things when attempting to modify behaviour in the reflective direction than they do when maintaining a reflective approach in their children. This implies that the use of impulse control followed by strategy instruction would most effectively change and then maintain reflectivity. It should be noted, however, that the children whose status changed were highly involved in the task and showed considerable concern about making mistakes.

Two remaining features of the mother-child interaction need to be discussed. First, consistent with previous findings associating a global, quick decision, information processing mode with impulsivity (Zelniker and Jeffrey, 1976), the impulsive children in this study (particularly impulsive sons with impulsive mothers) made the most number of conclusions about problem solutions. These children continually made premature solution decisions. Second, impulsive mothers with impulsive children generally let their children control the interaction session. More than other groups these mothers most frequently complied to their impulsive sons attempts at controlling their behaviour. Further, children with impulsive mothers made more task suggestions and impulsive mothers were least likely to initiate task relevant interaction. This picture of impulsive mothers suggests why their children do not readily become more reflective.

The significance of these differences in interaction patterns became even more apparent when the concurrent problem solving performance of mother-child pairs was examined. During the interaction all dyads did better than they had while working alone. However reflective-impulsive differences observed in the before interaction analyses were if anything exaggerated. Impulsive mothers with impulsive children were significantly less efficient at intersecting information than any other group, with reflective mothers and reflective children showing the most effective problem solving strategies. Contrary to before interaction analyses, the response time data here provided support for the hypothesis that reflectives and impulsives respond differently following success and failure. Children who were working with their reflective mothers took significantly longer to respond after negative feedback than children who were working with impulsive mothers. However, since reflective children with reflective mothers maintained higher response times than the other groups following positive feedback as well, the only group showing a truly differential response following failure as opposed to success, were impulsive children with reflective mothers. Since it was this same group of children who received the most impulse control statements from their mothers and who subsequently showed the greatest change toward reflectivity it is suggested that this differential response to positive and negative feedback is more a symptom of change toward overall longer response times than a factor distinguishing the behaviour of reflectives and impulsives in general.

Change in Performance After Interaction

The After Interaction alone sessions provided a test of whether the observed differences in mother-child interaction actually produced differential amounts of change in behaviour. While a practice effect could explain why children generally improved after the interaction, group differences in the analysis of standardized change can presumably only be related to differential experiences during the interaction phase. The changes in children's hypothesis-testing efficiency and problem solving strategies provide the strongest evidence for the importance of natural environmental contingencies in determining reflective and impulsive status. The only group not improving their hypothesis testing efficiency following the interaction were reflective children who had worked with their impulsive mothers. In examining the change in problem solving strategies and stereotypes, children who had worked with reflective mothers were found to have increased their use of solution strategies. This change was brought about by a substantial decrease in the use of solution strategies by children who had worked with impulsive mothers and an even larger increase by impulsive children who had worked with reflective mothers.

A further measure showing an effect of the interaction session was the children's private speech. Impulsive children who had worked with reflective mothers substantially decreased their use of feedback speech while impulsive children with impulsive mothers increased their use of this category. While private speech was not found to serve a guiding function in the sense that those who used self-guiding speech solved problems more effectively, it may have served other purposes.

Surely it is not simply coincidental that the same children who received very little task relevant feedback from their mothers were the same children who subsequently were so concerned with feedback in their private speech while working alone.

The final and most compelling evidence for the importance of environmental contingencies in determining the reflective-impulsive status of children rests in the finding that interaction patterns predicted the extent to which impulsive children would become more reflective. As indicated previously, children who changed the most answered more of their mother's questions and were more involved in the task. Mothers of these children used little indirect help and responded to their children with more questions, fewer negatives, and more impulse control statements. This result is particularly important as it shows that behaviour change was not confined to performance on the same task as the one where mother-child interaction patterns were observed.

No changes were observed in the childrens' scanning behaviour measures. Reflective children continued to fixate the correct stimulus proportionately more often following positive than negative feedback. This finding is consistent with the previous suggestion that reflective mothers initially use impulse control to produce change in the reflective direction and only later use indirect scanning strategy instruction for maintaining reflective behaviour. It would have been interesting to follow up the reflective mothers whose children had changed in the reflective direction to examine this hypothesis.

Even though the children's behaviour was the most dramatically effected by the interaction session, changes were not confined to them. Impulsive mothers who had worked with their reflective children both increased their use of solution strategies and decreased stimulus preference response patterns while working alone after the interaction session. It is perhaps surprising that the mothers were essentially unaware of the ways in which their own behaviour and that of their children differed from other mother-child pairs. The finding that these differences produced significant changes in children's problem-solving behaviour suggests that training mothers to be cognizant of the way in which they interact with their children may be the first step in a 'natural' modification technique.

Summary and Conclusions

- a) The importance of the match between mother and child cognitive tempos has been demonstrated. Impulsive children with impulsive mothers, impulsive children with reflective mothers, reflective children with impulsive mothers and reflective children with reflective mothers behaved differently in the problem-solving situations. It was suggested that further studies examine the match between father and mother tempos to determine if parental discrepancies in tempo predict which children will have tempos which differ from one parent.

- b) Analysis of the scanning behaviour of reflective and impulsive children indicated that reflective children fixated the correct stimulus proportionately more often following positive than negative feedback. Moreover, reflectives looked at the stimuli during a short fixed time interval following feedback more frequently than impulsives. These findings were interpreted as providing evidence for the hypothesis that the performance of reflective children is characterized by detailed visual feature analysis while impulsive children characteristically use a more global approach (eg. Zelniker et al, 1976). These differences in scanning behaviour did not discriminate the performance of reflective and impulsive mothers.
- c) Impulsive children with impulsive mothers were found to be less efficient at intersecting coded, recoded and retained information than reflective children. Only on measures involving this most demanding of the processes involved in efficient problem solving were subject groups distinguished. This same measure discriminated the performance of reflective and impulsive mothers.
- d) While children were found to differ in their use of particular categories of private speech, no relationship was found between the relative frequency with which the various types of private speech were used and the efficiency with which subjects solved problems. This effect was interpreted as indicating that private speech does not serve a functional verbal mediating role in

controlling discrimination performance. The mothers in the present study used considerable amounts of private speech while problem solving. This result suggested that private speech during problem solving is not gradually internalized when subjects get older as previous authors have suggested (eg. Kohlberg et. al, 1968).

- e) Response times of both reflective mothers and children were found to be generally longer than the response times of impulsive mothers and children. The tendency to increase response times more following continued failure as opposed to success or mixed feedback was only observed for impulsive children with reflective mothers during and after the interaction session with their mothers.
- f) Mother-child interaction patterns were found to differ as a function of a) the match in tempo between mother and child, b) the sex of the child and c) whether responses served as antecedents or consequents. Since these differences were also found to be related to subsequent improved problem-solving and Matching Familiar Figures Test performance, the critical role of these natural environmental contingencies in determining reflective and impulsive status was apparent. A discrepancy was obtained, however, between the characteristic interaction patterns of reflective mothers in general and mothers of impulsive children who subsequently changed their status in the reflective direction. For example, reflective mothers used the indirect strategy instruction method as an antecedent to their children's behaviour more than

any other group. However, mothers whose children who subsequently became more reflective used more impulse control statements. This suggested that mothers use impulse control initially to change behaviour in the reflective direction but then follow this with strategy instruction in order to maintain reflective behaviour. Impulsive mothers of impulsive children were found to let their children control the interaction session and were generally less involved in the task than reflective mothers.

- g) The mothers were found to be relatively unaware of the ways in which their own behaviour and that of their child's differed from the behaviour of other mother-child pairs. The present study provided support for the expectation that training mothers to be more aware of and to modify their own behaviour toward their children could prove an effective method of modifying tempos while using natural environmental determinants.

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Footnotes

1. In general, the studies reviewed include only those using the Matching Familiar Figures Test (or a comparable test) to measure reflection-impulsivity with normal populations. Studies examining the relationship between cognitive tempo and other style variables were excluded from analysis.
2. Both Weiner and Adams (1974) and Messer (1970) found the 'no' treatment group to perform in a manner similar to the 'failure' treatment group. According to Messer a high proportion of subjects who are retested on the same form of the MFFT twice within a relatively short time interval without any intervening treatment, state that they believe their earlier performance must have been poor (i.e., failure) to warrant a second test.

APPENDIX A

Parental Consent Form

CARLETON UNIVERSITY

OTTAWA, CANADA

K1S 5B6

DEPARTMENT OF PSYCHOLOGY

September, 1975.

Dear Parent,

The purpose of this letter is to request your cooperation in a research project which has been approved by the Carleton Board of Education. The project is aimed at providing much needed information about the learning process and will be conducted in two parts. Your son/daughter along with all the children in Grades 3 and 4 at Glen Cairn Public School has been chosen to participate in the first part of the research.

While children spend considerably more time at home than they do at school, most research on childrens learning has been conducted with professional teachers and children in school environments. The goal of this research is to further our understanding of the learning process outside the classroom since it is obvious that children learn a great deal in other environments (e.g. home, playground) and that parents have a specialized knowledge of the ways their children learn.

In the first part of the research, your child would be given, individually, a picture-matching test which takes approximately 20 minutes. This type of test has been used frequently and typically provides an enjoyable pause from regular activities. The results of the test are for the exclusive use of the research project and will not be placed on school records. Further, no child's name will appear on any report of the research.

A few children and their mothers will be invited to participate in the second phase of the research, but you will be contacted prior to that time. When the study is completed all parents will be invited to attend a general meeting at which the background for the research and the contribution of the present investigation will be fully discussed.

In the meantime, it would be greatly appreciated if you would give permission for your child to participate in the first part of the research. Thank you for your help.

Yours Sincerely,

(Margaret K. McKim)

.../2

-2-

PARENTAL CONSENT FORM

I give my permission for _____ (Student's Full Name)
(PLEASE PRINT)
to participate in phase one of the research.

OR

I do NOT give my permission for _____ (Student's Full Name)
(PLEASE PRINT)
to participate in phase one of the research.

Parent's Signature: _____ Date: _____

APPENDIX B

Detailed Description of Strategy Protocols

The technique for analyzing a set of protocols into the various Sys will be demonstrated here. This presentation will cover both the assumptions necessary to the analysis and the details of the procedures employed with the data. Portions of this protocol were obtained from Gholson, Levine and Phillips (1972).

The general conception: It is assumed that S begins a problem with some Sy, i.e., with some system that dictates his mode of sampling Hs. Each Sy is manifested in one of a small subset of H sequences. For example, the Sy Stimulus Preference is manifested when the same H is continually repeated after each of a series of disconfirmations. There is a small subset of these H-sequences since the particular H is not specified -- S might persevere on "large size", or on "black", etc.

A second assumption is that this Sy is maintained at least until the fourth feedback trial, i.e., the Hs observed after each of the first three feedback trials are dictated by a single Sy.

The third assumption concerns Ss' manner of resampling for Hs after a disconfirmation. The Hs are divided into two classes: Response-set Hs (defined as S's preference, or bias, causing him to produce long strings of stereotypic responses) and Prediction Hs (defined as S's prediction concerning the solution). Correspondingly,

the Sys are divided into two classes: Stereotypes (eg., Stimulus Preference), in which S persists in the same H despite repeated disconfirmations, and Strategies, in which S follows some plan which, in principle, leads to solution. During Strategies an H is genuinely tested, i.e., is rejected following a disconfirmation.

Finally, the set of Sys is specified a priori. For the present research the following set was considered:

Stimulus Preference (abb. S-P): S selects an H and persists with it for the three feedback trials.

Hypothesis Alternation (H-A): S selects an H from a particular dimension, tests it and if it is disconfirmed selects the alternative H from the same dimension. If that H is subsequently disconfirmed S tries the first H from the same dimension once again. Each H is locally consistent with feedback however.

Hypothesis Checking (abb. H-Ch): The eight Hs are ordered by S into the pairs of Hs from each of the four dimensions, as though S imagines a list of the four pairs of Hs. He goes through this list, testing each H in turn, one dimension at a time. Thus, he tries an H, then, if it is disconfirmed, he tries its complement (the opposite H on the same dimension). If that is disconfirmed he tries an H from another dimension, then its complement, etc.

Dimension Checking (abb. D): As with H-Ch the Hs are ordered by the four dimensions. In this case, S recognizes that after the first trial disconfirmation of an H also logically disconfirms the

entire dimension. (This is logically correct since the just-disconfirmed H was, when it had been sampled, locally consistent. Its complement, therefore, of necessity had at that time been locally inconsistent). After each disconfirmation, therefore, the H comes from a different dimension.

Focusing (abb. Fo): With each feedback S eliminates all disconfirmed Hs, whether explicitly manifested or not. Thus, each H manifested is locally consistent, and consistent with all the preceding feedback-trial information. The H after the third feedback trial is, of necessity, the solution.

The analysis: In principle, E's decision about the Sy employed by a particular S on a particular problem is simple. He inspects the first three Hs and, on the basis of the particular H sequence, decides which Sy is being manifested. However, a more detailed treatment of the general analytical technique is required because there is a complication. There is occasional overlap in the manifestation of two Sys. For example, an S who is following the D Sy may, when resampling after the third feedback trial, select the correct dimension and, perforce, the solution H. The resulting H sequence might be identical to that of an S following the Fo Sy. Such confounding requires special techniques for arriving at valid estimates of the frequency with which the various Sys occur. These techniques vary somewhat with each feedback sequence.

Because of this complication the categorizing of protocols will

be described separately for each sequence of feedback trials. Problems with confounding will be discussed as they arise. Before proceeding, however, a few definitions will be helpful: (1) The feedback, "correct" or "wrong" will be symbolized by + or -, respectively. A subscript (eg., $+_2$) will indicate the trial on which the feedback occurred. (2) The subscripts i, j, k , and l will refer to the four dimensions. Thus, the symbol H_j will refer to the first H seen from the j^{th} dimension. If the j^{th} dimension is color and "black" is the first H observed from this dimension, the $H_j = \text{black}$. The complementary, or opposite, H will be indicated by the prefix "op". Thus, if $H_j = \text{black}$ then $\text{op}H_j = \text{white}$. In general, the subscripts $i, \dots, l$ will be used in chronological sequence, so that i will be employed for the first dimension manifested in a problem, j for the second, etc. (3) The correct H , i.e., the solution, will be symbolized as H^+ . (4) Corresponding to the Sy labels, S-P, D-P, H-Ch, D, and Fo, will be the frequencies of these Sys: $f(\text{s-P})$, $f(\text{H-A})$, $f(\text{H-Ch})$, etc.

Sequence: $+_1 -_2 -_3$

Each experimental problem is tentatively catalogued as one of the four Sys according to the manifestation indicated.

Stimulus Preference (S-P) manifestation: $+_1 H_1 -_2 H_1 -_3 H_1$

Hypothesis Alternation (H-A) manifestation: $+_1 H_1 -_2 \text{op}H_1 -_3 H_1$

Hypothesis Checking (H-Ch) manifestation: $+_1 H_1 -_2 \text{op}H_1 -_3 H_1$

Dimension Checking (Tentative cataloguing, indicated by priming the symbol, D') manifestation: $+_1 \underline{H}_1 -_2 \underline{H}_2 -_3 (\underline{H}_k \neq \underline{H}^+)$

Focusing (tentative cataloguing, indicated by priming the symbol, Fo') manifestation: $+_1 \underline{H}_1 -_2 \underline{H}_2 -_3 (\underline{H}_k = \underline{H}^+)$. Also, $\underline{H}_j$ and $\underline{H}_k$ must be not only locally consistent but consistent with the first and second feedback trials as well. If this criterion is not met then the sequence is interpreted as a manifestation of D'.

Corrections required: After cataloguing the problems according to the sets of manifestations noted above, a correction is required. An S following the D Sy may choose an $\underline{H}_j$ which is consistent with the first feedback trial and an $\underline{H}_k = \underline{H}^+$. The resulting H sequence would (mistakenly) be catalogued as Fo thereby inflating its frequency estimate, $f(\text{Fo})$, and correspondingly decreasing $f(\text{D})$. The relative frequency with which this particular H sequence occurs (given that S holds D and responds so as to receive the feedback sequence $+_1 -_2 -_3$) may be estimated from the following considerations: The corrected D value contains two components, those sequences which cannot be confused with the Fo sequence (labelled D') and those sequences which resemble the Fo sequence (labelled D*). The frequency of D is the sum of the two frequencies, i.e.,

$$f(\text{D}) = f(\text{D}') + f(\text{D}^*) ,$$

where $f(\text{D}')$ is obtained directly from the data. Similarly, the sequences in the category labelled Fo' contain two different sets of sequences: those which are actually the result of the Fo Sy

(labelled Fo) and those which are from the D Sy (D*). These two frequencies combine giving

$$f(Fo') = f(Fo) + f(D^*) ,$$

where $f(Fo')$ is obtained directly from the data.

These two equations contain three unknowns. A third equation is obtained from these considerations: With orthogonal stimulus sequences an S who is holding the D Sy and who will receive $+_1$ and $-_2$ may start the problem with one of only two Hs (there are four Hs which lead to a correct response on trial 1; two of these lead to an error on trial 2). Starting with one of these two Hs, D*, the sequence resembling the Fo sequence, will occur one-fourth of the time; starting with the other H the Fo-resembling sequence, D*, will occur one-half the time. Since the probability that this S (holding the D Sy) will start the problem with each of these two Hs is one-half, the probability of D* occurring is given by $1/2(1/4) + 1/2(1/2) = 3/8$. Therefore, D' will occur $5/8$ of the time. The required third equation is then

$$f(D^*) = (3/5)f(D') .$$

Solving the three equations yields:

$$f(D) = f(D') + (3/5)f(D')$$

$$\text{and } f(Fo) = f(Fo') - (3/5)f(D') .$$

Thus, the value $(3/5)f(D')$ must be added to and subtracted from, respectively, the initial, tentative frequency assignments for the D Sy and the Fo Sy.

Sequence: $-1 \quad -2 \quad -3$

S-P manifestation: $-1_{-1}^H \quad -2_{-1}^H \quad -3_{-1}^H$

H-A manifestation: $-1_{-1}^H \quad -2_{opH}^H \quad -3_{-1}^H$

H-Ch manifestation: This Sy has two sets of sequences depending upon whether one assumes that S holds an H before the problem starts or whether one assumes that S receives information from the first trial before applying his Sy. Each procedure yields its own unique sequence. Either sequence, therefore, was regarded as an instance of H-Ch.

These sequences are: $-1_{-1}^H \quad -2_{-1}^H \quad -3_{opH}^H$ or $-1_{-1}^H \quad -2_{opH}^H \quad -3_{-1}^H$

D' manifestation: $-1_{-1}^H \quad -2_{-1}^H \quad -3_{(H_k \neq H^+)}^H$

Fo' manifestation: $-1_{-1}^H \quad -2_{-1}^H \quad -3_{(H_k = H^+)}^H$

The same confounding between D and Fo exists with this feedback sequence as with the preceding. Also, the same correction procedure is appropriate:

$$f(D) = f(D') + (3/5)f(D'), \text{ and}$$

$$f(Fo) = f(Fo') - (3/5)f(D'),$$

where $f(D')$ and $f(Fo')$ are frequencies obtained from the initial cataloguing.

Sequence: $+1 \quad +2 \quad -3$

S-P manifestation: $+1_{-1}^H \quad +2_{-1}^H \quad -3_{-1}^H$

H-A manifestation: indistinguishable from H-Ch (all instances assigned to H-Ch)

H-Ch manifestations: $+_1\bar{H}_1 +_2\bar{H}_1 -_3^{op}H_1$

D' manifestation: $+_1\bar{H}_1 +_2\bar{H}_1 -_3(\bar{H}_j \neq H^+)$

Fo' manifestation: $+_1\bar{H}_1 +_2\bar{H}_1 -_3(\bar{H}_j = H^+)$

Here, again, an S holding the D Sy would, if the correct dimension were second on his list, produce a sequence resembling focusing. Since the correct dimension cannot be first on this S's list (the given feedback sequence has an error on trial 3, an impossible event if S started out holding H⁺) it may be either second, third, or fourth. One-third of the time it will be second and a Fo sequence will result, i.e.,

$$P(D^*|D) = 1/3, \text{ and } P(D'|D) = 2/3.$$

Therefore, $f(D^*) = (1/2)f(D')$, and

$$f(D) = f(D') + (1/2)f(D')$$

$$f(Fo) = f(Fo') - (1/2)f(D').$$

Sequence: $-_1 +_2 -_3$

S-P Manifestation: $-_1\bar{H}_1 +_2\bar{H}_1 -_3\bar{H}_1$

H-A Manifestation: indistinguishable from H-Ch (all instances assigned to H-Ch).

H-Ch' Manifestation: $-_1\bar{H}_1 +_2\bar{H}_1 -_3^{op}H_1$

D' Manifestation: $-_1\bar{H}_1 +_2\bar{H}_1 -_3(\bar{H}_j \neq H^+)$

Fo' Manifestation: $-_1\bar{H}_1 +_2\bar{H}_1 -_3(\bar{H}_j = H^+)$

Correction required: One-third of the time an S who holds the D Sy and who receives the feedback sequence $-_1 +_2 -_3$ will have the correct dimension second on his list. Therefore,

$$P(D^* | D) = 1/3, \quad P(D' | D) = 2/3, \quad \text{and}$$

$$f(D^*) = (1/2)f(D').$$

The appropriate corrected equations are

$$f(D) = f(D') + (1/2)f(D'), \quad \text{and}$$

$$f(Fo) = f(Fo') - (1/2)f(D').$$

Table 11 summarizes the foregoing, showing the different response patterns associated with the five Sys when the feedback sequence is

+ - - .

APPENDIX C

Observational Procedure

The present recording procedure was derived from the response-class matrix technique described by Mash (1973). This technique makes possible the recording of particular behaviours in relation to specified antecedent and consequent events in the environment. Observations of mother-child interactions were recorded on the two matrices which follow. The first matrix is the Child's Consequent Behaviour Record with nine possible antecedent mother behaviours as row headings and nine possible child consequent behaviours as column headings. The second matrix is the Mother's Consequent behaviour Record with nine possible antecedent child behaviours and nine possible mother consequent behaviours as column headings.

Two observers are used, with one recording on matrix 1 and the other simultaneously recording on Matrix 2. A time-sampling observation method was employed. Each observer makes a mark in one of the matrix cells after 10 seconds. Only the first behaviour unit to occur in the 10 second interval is recorded. Following recordings, there is a 5-second pause, and then the next 10 second recording interval begins. The beginning and end of each 10 second observation interval is indicated by a 'beep' superimposed on the videotaped 20-minute mother-child interaction sequence.

Here is an example of how the procedure is applied to a mother-child interaction sequence.

Matrix 1: Child's Consequent Behaviour Record

Mothers Antecedent Behaviour	Compliance	Independent Responding	Task Suggestions	Conclusion	Impulse Control	Negative	Interaction	Comments	No Response
Indirect Help									
Question									
Praise									
Neutral									
Negative									
Direct Help									
Conclusion									
Impulse Control									
No Response									

Notes:

Date:

Time:

C Subject No. _____

Observer _____

Original _____ or Check _____

Matrix 2 Mother's Consequent Behaviour Record

Child's Antecedent Behaviour	Indirect Help	Question	Neutral	Negative	Direct Help	Conclusion	Impulse Control	Praise	No Response
Compliance									
Independent responding									
Task Suggestion									
Conclusion									
Impulse Control									
Negative									
Interaction									
Comments									
No response									

Notes: Date: _____ Time: _____ M Subject No. _____
 Observer: _____ C. Subject No. _____
 Original _____ or Check _____

During the first 10-second interval, the mother gave a command (1), the child complied (2), and, the mother praised. The observer would place the number 1 on the Childs Consequent Behaviour Record in the cell corresponding to mother command-child complies. The observer using the Mother's Consequent Behaviour Record would enter the number one in the cell corresponding to child complies-mother praises. At the end of the second 10-second period the observer using matrix 1 would place a two in the cell mother questions-child interacts. The observer using matrix 2 would place a two in the child interacts-mother commands cell following the second 10-second period. This scoring procedure continues for the whole 20-minute observation period.

In order that this system be meaningful, it was necessary to decide on certain functional definitions for each of the mother and child behaviours included in the matrix. These definitions are provided below.

Definitions of Maternal Response Classes

1. Indirect Help: In this category are statements made by the mother

which do not suggest a particular response or solution to the problem (i.e. distinct from direct help) but do aid in the solution. It may be a strategy suggestion or simply a list of alternative solutions. It may take the form of an imperative, command in interrogative form or a descriptive statement. For example,

- a) "OK, we've got black, circle, white or on the right."
- b) "Don't you think we should try and remember what has happened before?"
- c) "Remember it can be black or white, circle or square, large or small or right or left."
- d) "If this is wrong we can try one of the sizes or one of the positions."

2. Question: Scored in this category are any direct questions not of the command-question type. For example,

- a) "What... (were you going to do)?"
- b) "Do you remember...?"
- c) "Which one... (is correct)?"
- d) "How does...?"
- e) "Who...?"
- f) "When did...?"

3. Praise: The praise category includes both verbal statements and nonverbal actions indicating encouragement, acceptance, and/or approval of the child's behaviour. For example,

- Verbal:
- a) "You can do it."
 - b) "OK"
 - c) "Good"
 - d) "That's fine"
 - e) "I like that..."
 - f) "Aren't you doing well!"

- Nonverbal:
- a) Pat on the back
 - b) Hug
 - c) Head nod
 - d) Smile

Some judgement can be used in interpreting the context and tone of voice in scoring praise. A general rule is that most of the above statements when they follow a specific behaviour on the part of the child, are scored as praise. For example, if on complying with a command the mother says "OK", score as praise. However, if the child asks if he can work on the task himself and the mother says "OK", score as 'neutral' for the mother.

4. Neutral: This category includes any general statement about the task or the child's behaviour which does not have strong emotional overtones but may express interest or attention. It is often descriptive and may be in response to a question. A neutral statement which does not relate to the child's immediate behaviour or the task itself is scored as 'no response'. Some examples are,

Verbal: a) "That's interesting"

b) "mm 'hmm"

c) "They are in there"

d) "I wonder..."

e) "I think we'll do all right"

Nonverbal: a) general smiling (eye contact must occur and smiling may only be scored neutral if it is not 'praise')

b) laughing

c) physical contact that is neither 'negative' or 'praise'.

5. Negative: The negative category includes both verbal statements and nonverbal actions indicating discouragement, non-acceptance, and/or disapproval of the child's behaviour.

a) Verbal: Negative statements may take many forms. They may be either 1) direct disapproval or criticism:

a) "No, you're wrong..."

b) "That's not right..."

c) "You can do better than that..."

d) "I don't think you're right..."

or 2) implied criticism or threat:

a) "You'd better watch it!"

b) "I told you so."

b) Nonverbal: a) shove

b) shake head "no" (in the sense "That's wrong")

c) frown

d) slap

Negative behaviour takes precedence over a command. For example if the mother said "Do as I say!" in a threatening manner, this is scored as negative behaviour, rather than as a command.

6. Direct help: Direct help is scored only when the mother actually responds for the child (i.e. nonverbal) or specifically tells the child which stimulus to pick. (i.e. verbal).

Verbal examples are,

- a) "Push the black one..."
- b) "I think you should try that one."
- c) "Don't you think that one is right?"

Direct help takes precedence over every other behaviour category except conclusion.

7. Impulse Control: This category includes any statement aimed at inhibiting the child's immediate behaviour. Impulse control may often take the form of controlling response times (slower or faster).

Direct help takes precedence over impulse control but impulse control takes precedence over negative. Examples of impulse control are;

- a) "Don't you think you'd better slow down"
- b) "Wait"
- c) "Hurry up"
- d) "Don't do that"
- e) "Stop and think"

8. No Response: No response is scored when, during the 10-second interval the mother makes no task related responses. For example,

Verbal a) "Do up your shoelaces"

bb) "What did you do in the other room"

c) "Do you like the girl?"

Nonverbal a) Mother watches child but child does not look at her

b) Mother looks around the room

c) Mother lights a cigarette.

9. Conclusion: Any statement which would have been categorized as direct or indirect help but is made in the interval immediately following feedback. This category also includes any statement made at any other time during a problem which is presented in a semi-logical (often negative) form. For example,

a) "It can't be black"

b) "If it is not black then it must be white."

c) "Black" (immediately following feedback)

d) "It must be large then."

Conclusion takes precedence over every other category except direct help.

Definitions of Child Variables

1. Compliance: Compliance is scored for the child only when his behaviour is in response to the mother's command, direct help or impulse control command. Thus a child's answering a mother's question should not be scored as compliance, but as interaction. Any response

ranging from approximation to full compliance may be classified as compliance. Even if a child is having a tantrum, whining.... if he is complying at the same time, his response is scored as compliance. If the child is given a command relating to a specific task (eg. "Always pick the black one"), then compliance is coded in every 10-second interval that the child continues to comply (i.e. not coded as independent responding). It is assumed that any behaviours following a command that are not compliance, are behaviour competing with compliance. The Child's Consequent Behaviour Record (Matrix 1) facilitates recording of what the child does when he is not complying. (eg. responds independently, asks a question, makes no response...). If several commands are given in a 10-second interval, the child's response to the last command given is the response recorded.

2. Independent Responding: Independent responding is recorded when the child is responding on his own and not interacting with the mother. On the Mother's Consequent Behaviour Record (Matrix 2) independent responding is scored as a 'negative' child antecedent if it is actually noncompliance (i.e. ignoring a previous command).

3. Task Suggestions: Any statement made by the child in which a suggestion concerning a particular solution or a general strategy is made. Task suggestions take precedence over 'comments', 'interaction', or 'impulse control'. Examples are,

- a) "I think this is right..."
- b) "I'm going to push the right ones"
- c) "Circle."
- d) "Don't you think this one must be black?"

4. Impulse Control: Commands, command questions or negative commands directed toward the mother which are aimed at controlling the mother's behaviour. For example,

Verbal: a) "Wait, mom"

b) "Let me,"

c) "Answer me."

d) "Hurry"

e) "Don't you think it's my turn now?"

f) "Don't do that."

Nonvocal: a) holding mother's hand back from stimuli.

5. Negative: The negative category for the child includes all verbal statements and nonverbal actions indicating anger, refusal, or discouragement. As a child antecedent on the Mothers Consequent Behaviour Record (Matrix 2) all noncompliance to a previous command given by the mother is also scored as negative. 'Impulse Control' takes precedence over negative. Examples of negative behaviour are,

Vocal a) "No!" (must follow a command)

b) crying, whining, yelling

c) "I can't do it"

d) "This is terrible"

Nonvocal a) hit, push, pull away from mother

b) stomp floor, turn away, hit apparatus

c) hit self.

6. Interaction: Interaction is an attempt to initiate or maintain some type of mutual contact. Interaction is scored only when, during

a 10-second interval no other response occurs. It should be noted that interaction may not be two-way. The child may be attempting to interact with the mother, but she need not reciprocate. Interaction may be either verbal or nonverbal.

a) Verbal: comments that may be neutral, pleasant or descriptive but must be task related. An off-task statement is scored as no response. Verbal examples of interaction are,

- 1) the child's asking a question
- 2) the child's answering a question
- 3) descriptive statements directed toward the mother.

b) Nonverbal:

- 1) smiling or laughing with mother
- 2) physical contact other than negative.

7. Comments: Any statement made by the child not directed to the mother. These may be in the form of word play, remarks directed toward non human objects, descriptions of own activity, self-guiding comments, questions asked and answered by the self, inaudible muttering. 'Comments' take precedence over 'no response'.

8. No Response: No response is scored when, during the 10-second interval the child makes no task related responses. For example,

Verbal: a) "I'd like to go home"

b) "Were you talking about me with her?"

c) "I like this chair"

Nonverbal: a) Child looks around the room

b) Mother talks to child and child looks away and does not answer.

9. Conclusion: Any statement made by the child which would have been categorized as a task suggestion but is made in the interval immediately following feedback. This category also includes any statement made at any other time during a problem which is presented in a semi-logical (often negative) form. For example,

- a) "White was wrong so we won't do it again"
- b) "Circle then"
- c) "Big ones!" (immediately following feedback)
- d) "Wrong, so it must be..."

Conclusion takes precedence over every other category except task suggestion.

The matrix system just described groups specific behaviours into broad response classes. Beyond these observations it is useful for the observer to describe some detail after a session to clarify the behaviours that were recorded. The section below the Matrix was provided for noting information of this type.

Ten percent of the interaction sessions were coded twice by each of two observers in order to obtain estimates of the reliability of their observations. That is, each observer coded the same session twice; once using the Child Consequent Behaviour Record and the second time using the Mother's Record. The percent agreement between the two observers for each response category (using the formula, two times the number of agreements/sum of the tallies from both codes in any particular category) was used to analyze reliability.

Agreement was scored only if both observers had the same observation number in the appropriate response category. Johnson and Bolstad (in Hammerlynk, Handy and Mash, 1973) have indicated that the procedure is only appropriate if agreement is based on the concordance between the observation numbers in each response category.

Appendix D

Questionnaire on Interaction Session

Questionnaire on Interaction Session

Date: _____

Child's First Name: _____

Filled out by: _____

You and your daughter/son have just worked on a task together. Now I would like to know how you think the session went. After reading the questions on the next page, please draw a circle around the number on the seven point scale beside each question which best represents your answer.

		Never						Always
1. When you told your child to do something did he/she do it?	n/a	1	2	3	4	5	6	7
2. When you asked your child a question did he/she answer?	n/a	1	2	3	4	5	6	7
3. When your child did something you asked, did you show your approval (verbally or non-verbally)?	n/a	1	2	3	4	5	6	7
4. When you asked your child to slow down or answer more quickly, did he/she do as you asked?	n/a	1	2	3	4	5	6	7
5. Did your child accept and act upon your <u>specific</u> suggestions re: solving the problem?	n/a	1	2	3	4	5	6	7
6. When your child did not obey you, did you show your disapproval (verbally or nonverbally)?	n/a	1	2	3	4	5	6	7
7. If your child made a prediction about the solution to a problem, did you let him/her try it out even if you knew he/she wasn't right?	n/a	1	2	3	4	5	6	7
-
		Never						Frequently
8. Did you ask your child to a) respond more quickly, <u>or</u> b) answer more slowly?	n/a	1	2	3	4	5	6	7
9. Did you give <u>specific</u> suggestions to your child concerning how to solve the problem or what responses to make?	n/a	1	2	3	4	5	6	7
10. When your child was working on the problems independently, did you interrupt and suggest another way to solve the problem?	n/a	1	2	3	4	5	6	7
11. Did your child ask <u>you</u> to wait, slow down, hurry up, go faster....?	n/a	1	2	3	4	5	6	7

(over)

12. Did your child make suggestions about solving the problem(s)?
- Never
n/a 1 2 3 4 5 6 7 Frequently
13. Did you find your interest lagging while you and your child were working on the problems together?
- n/a 1 2 3 4 5 6 7
14. Did your child make comments about his/her own performance or about the task which did not seem to require an answer?
- n/a 1 2 3 4 5 6 7
-

15. Did you give general instructions about the strategy for solving the problems (ie. instructions not directed toward a specific solution)?

Yes _____ No _____ (Please check one)

16. Is there anything that happened in the session which you feel is not adequately covered in these questions? If so, please specify.

17. How did your child's behaviour during the session compare with the way he/she is when you work together at home? Please be specific.

18. Normally, how often do you and your child work together at a specific activity (including indoor, outdoor, recreational or academic activities)? Circle only one answer.

1. more than three times a day
2. one or more times a day
3. about three times a week
4. about once a week
5. less than once a week
6. about once every two weeks.

19. Do you expect your child to,

1. complete Grade 10
2. finish High School (Grade 12 or 13)
3. attend a community college.
4. attend at least one year of University
5. obtain a University degree
6. take specialized training beyond a Bachelor's degree
7. Other (please specify): _____

Circle the one answer which best represents your expectation.

THANK YOU VERY MUCH FOR YOUR PARTICIPATION

END

5

08

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FIN