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EVALUATION OF ONE'S TASK PERFORMANCE IN REFLECTIVE AND IMPULSIVE CHILDREN : ANALYSIS OF METACOGNITION

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We administered the Matching Familiar Figures Test (MFFT) as a criterion measure of cognitive reflection-impulsivity to 161 3rd graders and 167 6th graders. Immediately after this test, we interviewed all of the children individually about metacognitive knowledge and activities such as their interpretation of a task goal or requirement, ways of allocating their efforts to enable accurate and fast reaction, etc. There was a significant difference between reflectives and impulsives on self evaluation of errors in the MFFT and this result might be attributed to actual large differences between the two style groups. However, while reflectives took about 2.5 times the length of the time taken by impulsives before choosing the first answer, their subjective estimation of time taken was almost same as that of impulsives.

Although the majority of children categorized as either of the cognitive styles were thinking that accuracy was more important than speed, reflectives were actually tending to allocate more effort resources toward accuracy, but in contrast to this, impulsives did not differentiate between the two types of effort resources. In addition, reflectives were apt to pause and take more time on items which were judged as more difficult than others, but impulsives did not seem to modulate their cognitive effort in tuning the level of difficulty.

Key words: reflection-impulsivity, conceptual tempo, cognitive style, metacognition, individual differences in decision making processes

INTRODUCTION

Cognitive reflection-impulsivity is concerned with the individual differences in evaluating one's solution hypotheses in cognitive problems which contain response uncertainty (Kagan, 1971). This concept is operationally defined through the Matching Familiar Figures Test (Kagan *et al.*, 1964) which involves matching familiar figures. In this test, the standard and six variants which are same as the standard except for

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small details, are presented simultaneously. We measure the latency to first choice of any variants and the number of errors and classify into four cognitive style groups using the double median split procedure with two measures: reflectives, impulsives, fast/accurates, and slow/inaccurates. Roughly speaking, the two major cognitive styles share one-third each and the other two styles share one-sixth each, but as stability of the latter groups is very low with only less than one-third having continued to remain the same style during the one year from second to third and fifth to sixth grade in elementary school (Usui, 1982), we will focus on the former two styles: reflectives and impulsives.

Since fast reaction tends to lead to more errors with deliberately slower reaction tending to reduce errors, these two measures explicitly correlate negatively to each other. In other words, we can redefine this test situation as the mutually incompatible task goals of fast solution against accurate choice. So a trade-off must occur contradicting goals. That is to say, some aspects of metacognitive processes, such as the interpretation of the goals, evaluation of task difficulty, and distribution of effort etc, will determine the task performance of children. This would indicate the necessity for more in-depth research in this area, but up to now, with a few exceptions (e.g., Kurtz, 1984; Nakazawa, 1986), there have been relatively scant research findings concerning metacognitive processes.

Finally, immediately after the MFFT, we attempted to analyze the self-report pertaining to the metacognitive activities of the elementary school children, and clarify some of the variables which determine the reflective and impulsive cognitive styles by comparing the activities of the two groups.

METHOD

Subjects

One hundred and sixty-one third graders (87 boys and 74 girls) and 167 sixth graders (84 boys and 83 girls) took part in these experiments. The average age at administering the MFFT was 9:2 for 3rd graders and 12:2 for 6th graders.

Procedure

We individually administered on all of the subjects the shorter version (15 items) of the MFF-20 (Figure 1) (Cairns and Cammock, 1978) and asked the following questions immediately after the test.

Content of questions was as follows:

1. number of items child found difficult (any number)
2. degree of effort devoted to the accuracy of choice (six-point scale, from 6 as the highest to 1 as the lowest)
3. degree of effort devoted to speed of choice of any of the variants (six-point scale, from 6 as the highest to 1 as the lowest)
4. evaluation of one's errors (six-point scale, from 6 as the highest to 1 as the lowest)
5. evaluation of one's latency to the first response (six-point scale, from 6 as the

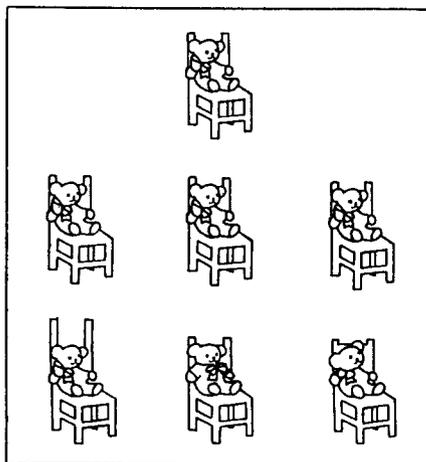


FIG. 1 An item excerpt from MFFT

highest to 1 as the lowest)

6. belief about the value of accuracy in responses (six-point scale, from 6 as the highest to 1 as the lowest)

7. belief about the value of speed in responses (seven-point scale, from 7 as absolutely agreeing to 1 as absolutely disagreeing)

8. belief about the effectiveness of longer latency for decreasing errors (seven-point scale, from 7 as absolutely agreeing to 1 as absolutely disagreeing)

9. the general difficulty of the items (seven-point scale, from 7 as extremely difficult to 1 as extremely easy)

We asked these questions with the aid of cards on which were written the pertinent questions and answer options (six to seven options).

It took about half an hour to complete whole procedure (MFFT and the interview).

RESULTS AND DISCUSSION

Classification of children

We classified the reflective and impulsive children using double median split criterion children of total errors and latency in the MFFT. In other words, the child who scored above the group median for one's grade in latency to first response and were below the median in terms of errors were classified as reflective. The opposite criteria were used to classify children as impulsive. This resulted in 64 (36 boys and 28 girls) reflectives and 62 impulsives (36 boys and 26 girls) among the third graders, and 62 (30 boys and 32 girls) reflectives and 67 (36 boys and 31 girls) impulsives among the sixth graders.

The correlation between latency and errors for both grades was satisfactorily high as $-.64$ ($p < .001$) and $-.62$ ($p < .001$) at third and sixth grade respectively.

Comparisons of reaction to metacognitive questions

Reflectives in both grades were significantly underestimated their errors ($p < .01$, $p < .01$ for 3rd and 6th graders respectively) and expected greater effort to make accu-

rate choice than both grades of their impulsive counterparts, although the differences were almost significant for 6th graders ($p < .05$ and $p < .10$ for 3rd and 6th graders). Since there was an extremely great difference in the number of errors between the two cognitive style groups (6.89 vs. 19.84 and 4.10 vs. 14.21 for reflectives and impulsives at 3rd and 6th grade), these differences were naturally expected.

But, their evaluation of latency did not seem to be congruent with any salient differences between the cognitive styles (289.70 sec. vs. 103.78 sec.; 258.00 sec. vs. 104.70 sec. for reflective and impulsive children at 3rd and 6th grade respectively). That is, reflectives in both grades evaluated their reaction time just the same as impulsives did. This finding implies that there existed a different frame of time estimation system or internal clock among the two styles (Walker, 1982; Usui, 1985).

Comparisons of metacognitive knowledge and its execution (distribution of cognitive effort)

How did reflectives and impulsives interpret the task requirements of MFFT? Also what did they think about the strategies which seemed to be more successful in solving the tasks? We tried to analyze the nature of metacognitive knowledge and actual distribution of their efforts.

(1) Accuracy vs. speed: In order to determine the relative emphasis on accuracy and speed within a subject, we compared the score of the degree of importance of accuracy and speed of each subject (Table 1), and sorted them into two groups (accuracy emphasize and speed emphasize). If their score for accuracy was higher than

TABLE 1
Mean scores of metacognitive interviews

	3rd (Ref=64, Imp=62)		6th (Ref=63, Imp=67)	
	reflectives	impulsives	reflectives	impulsives
number of difficult items	3.79 (1.76)	4.82* (2.67)	4.04 (2.52)	4.63 (2.41)
amount of effort to accuracy	4.44 (1.13)	3.94* (1.16)	4.80 (0.91)	4.43(*) (1.05)
amount of effort to fast response	4.06 (1.36)	3.98 (1.45)	4.20 (1.15)	4.50 (1.22)
importance of accuracy	6.03 (0.93)	5.95 (0.93)	5.61 (1.06)	6.09* (0.93)
importance of fast response	5.08 (1.36)	5.26 (1.29)	4.91 (1.26)	5.02 (1.51)
self evaluation of errors	3.81 (1.04)	4.35** (1.19)	3.65 (1.39)	4.74** (0.84)
self evaluation on latencies	4.17 (0.95)	4.05 (1.03)	4.35 (0.82)	4.30 (0.99)
effectiveness of slower latency	4.95 (1.25)	4.94 (1.37)	5.24 (1.16)	5.28 (1.51)
global ratings of difficulty	4.88 (0.93)	4.79 (1.37)	5.20 (0.91)	5.00 (1.26)

(*): $P < .10$, *: $P < .05$, **: $P < .01$

figures in parentheses indicate standard deviations

TABLE 2
Classification of accuracy emphasizees and speed emphasizees

	Reflectives		Impulsives		Total	
	3 rd grade	6 th grade	3 rd grade	6 th grade	3 rd grade	6 th grade
Speed Emphasizers	14 (22.6%)	5 (11.4%)	17 (30.4%)	6 (11.8%)	31 (26.3%)	11 (11.6%)
Accuracy Emphasizers	48 (77.4%)	39 (88.6%)	39 (69.6%)	45 (88.2%)	87 (73.7%)	84 (88.4%)

that of speed, they were were classified as an “accuracy emphasizee” and if the former was lower than the latter, then they were classified as a “speed emphasizee”. As shown in Table 2, the percentage of accuracy emphasizees significantly increased from 3 rd (73.7%) to 6 th graders (88.4%) ($\chi^2=7.18$, $df=1$, $p<.001$). Furthermore, there were consistently more accuracy emphasizees regardless of the difference in cognitive styles.

This result suggested that children gradually became more concerned with accuracy during middle childhood, with reflectives as well as impulsives preferring accuracy to speed, though there were great differences in latencies and errors between both styles.

(2) Effectiveness of delaying latency on decreasing the number of errors: Both reflective and impulsive children of both grades admitted the effectiveness of slower latency to decrease errors. Their mean rating scores were around 5 points which mean “agree” on the seven point scale (from 7: absolutely agree to 1: absolutely disagree).

While reflectives as well as impulsives thought that the strategy of taking more time would lead to more accurate answers, why was it that impulsives actually did not use this strategy? Or maybe impulsives felt that their decision time was long enough to be effective to reduce errors. Or possibly, they did know of the strategy and felt that they had used it, but that they did not activate it and did not moderate their less preferred strategy (Neimark, 1985). That is, it is suggested that this difference seemed to have stemmed from the execution process of metacognitive knowledge rather than the knowledge itself.

(3) Actual distribution of effort: Although reflectives felt that they devoted more effort to accurate choice than impulsives regardless of grades, the effort devoted to fast choice did not differ between styles. Then we compared scores of the two kinds of effort for each subject and if the scores of accuracy were higher than that of speed, we classified them as “accuracy seekers”. And if the scores were the reverse, we classified them as “fast choice seekers”. As shown in Table 3, the number of accuracy seekers tended to increase developmentally (57.0% vs. 71.2% for 3 rd and 6 th graders respectively). Also, we found there were relatively large differences between styles. For example, the accuracy seekers accounted for 63.7% and 77.8% of reflectives in contrast with 50.9% and 47.2% for impulsives (3 rd and 6 th graders respectively). While impulsives evaluated the importance of accuracy significantly higher than reflectives at 6 th grade (Table 1), they felt that a smaller amount of effort resource had been devoted to accuracy than 3 rd and 6 th grade reflectives.

TABLE 3
Classification of fast choice seekers and accuracy seekers

	Reflectives		Impulsives		Total	
	3 rd grade	6 th grade	3 rd grade	6 th grade	3 rd grade	6 th grade
Fast choice Seekers	22 (37.3%)	10 (22.2%)	27 (49.1%)	28 (52.8%)	49 (43.0%)	38 (38.8%)
Accuracy Seekers	37 (63.7%)	35 (77.8%)	28 (50.5%)	25 (47.2%)	65 (57.0%)	60 (71.2%)

Mean latencies and errors for difficult and easy items

Regarding the number of items judged as difficult, impulsives counted significantly more items in number than reflectives at 3rd grade, but there was no

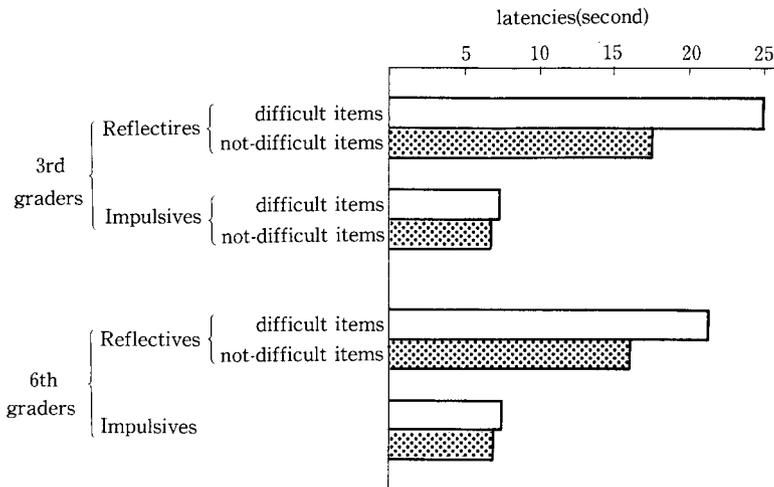


FIG. 2 Mean latencies of difficult and not-difficult items

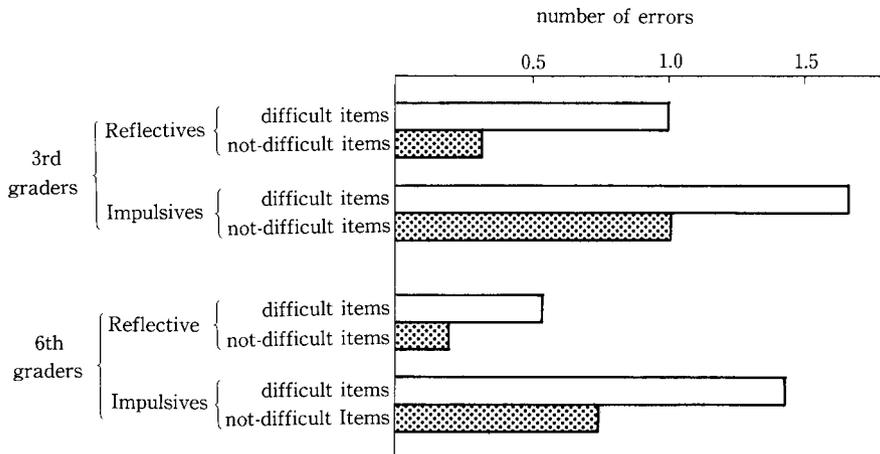


FIG. 3 Mean number of errors of difficult and not-difficult items

difference at 6th grade (Table 1). However, when we come to compare latencies for difficult vs. not difficult items, we can find clear differences between styles (Figure 2). While reflectives tended to modulate their latency to their estimation of difficulty, impulsives responded to each item in the same fashion. Both reflectives and impulsives judged an item as difficult if they had made more errors on it, although there were great differences in errors between the groups (Figure 3). So having experienced failures determined the rough judgment of difficulty for both styles similarly.

In summing up, judgment of the degree of difficulty by impulsives seemed to largely depend on the resultant errors, and to some extent, this was the same for reflectives, but in addition to this, the latter style might use the length of time needed to detect one plausible answer as another clue in judging their subjective level of difficulty. And/or they actively moderate decision time and mobilized their resources if they were faced with tricky figures in the MFFT. Or, they might utilize their strategy more effectively than impulsives.

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