ABSTRACT. In this study, the authors improved the understanding of the cognitive processes underlying the reflective–impulsive cognitive style (RI), which was initially measured by J. Kagan, B. L. Rosman, D. Day, J. Albert, and W. Phillips (1964) on the Matching Familiar Figures Test (MFFT). The authors determined the relationships between the RI style and the cognitive factors, which would be likely to explain different MFFT solving modes—field dependence or independence as a cognitive style, the g factor, the spatial factor, and a metacognitive control index, which the authors developed for this study. The hypotheses were largely based on various studies (J. P. Ancillotti, 1984, 1985; J. Kagan, B. L. Rosman, D. Day, J. Albert, & W. Phillips, 1964; T. Zelniker & W. E. Jeffrey, 1976; T. Zelniker, A. Renan, I. Sorer, & Y. Shavit, 1977). The results are presented separately for each of four groups: (a) reflective individuals, who implement an analytic process and are cognitively mature; (b) impulsive individuals, who use a holistic process and are cognitively immature; (c) fast-accurate individuals, who are capable of implementing both analytic and holistic processes and exhibit cognitive maturity; and (d) slow-inaccurate individuals, who exhibit good metacognitive control but have trouble implementing both types of processing.

Key words: cognitive processes, cognitive style, reflective–impulsive
process the information they apply to solving problems. In other words, different individuals preferentially use qualitatively different adaptive processes.

Kagan et al. (1964) were the first researchers to propose the RI, which they measured using the Matching Familiar Figures Test (MFFT). This visual comparison task requires participants to select the one figure that matches a standard from several alternative figures. Two variables are measured—latency (time taken to respond) and accuracy (number of errors). Kagan et al. classified people into two groups on the basis of their scores on these two variables relative to the median—reflective individuals (long latency, high accuracy) and impulsive individuals (short latency, low accuracy).

With respect to the cognitive processes, Ancillotti (1984) found that reflective individuals used an analytic processing mode, whereas impulsive individuals used a holistic processing mode (Rollins & Gensler, 1977; Zelniker & Jeffrey, 1976; Zelniker, Renan, Sorer, & Shavit, 1977). Ancillotti (1984, 1985) proposed that impulsive individuals lacked cognitive maturity, usually assessed by their operating level. Lawry, Welsh, and Jeffrey (1983) found a similar result in that reflective individuals performed better than did impulsive individuals on Raven’s Progressive Matrices (1998). Borkowski, Peck, Reid, and Kurtz (1983) showed that reflective individuals exhibited superior metamemory compared with impulsive individuals.

Zelniker et al. (1977) found no difference in the general intelligence level of these two groups: Impulsive individuals tended to use a different processing mode (holistic) than did reflective individuals. The MFFT task requires individuals to use analytic processing, which does not fit with the preferences of impulsive individuals. Inversely, reflective individuals, who generally use an analytic processing mode, are not as adept at adopting holistic processing on tasks that require it. To demonstrate this, Zelniker and Jeffrey (1976) modified the MFFT task so that it would include both global items and analytic items. Unlike Kagan et al.’s (1964) MFFT items, those global items did not differ by a detail, rather they differed by the contour of the figure, which formed a gestalt. The results showed that analytic items were advantageous for reflective individuals, whereas global items were beneficial to impulsive individuals. On global items, the impulsive individuals outperformed the reflective ones in that they took less time but did not make more mistakes.

The RI style is sometimes compared with another type of cognitive style—Witkin, Ottman, and Raskin’s (1985) field dependence or independence (FDI). Riding and Sadler-Smith (1992), for example, treated the two as if they were the same by considering both to be based on analytic processing. From the standpoint of cognitive processes, FDI favors individuals who use an analytic strategy to ones who use a global strategy (Huteau, 1987), particularly in Kohs blocks (Rozencwajg & Corroyer, 2002; Rozencwajg & Huteau, 1996).

If field-dependent individuals and impulsive individuals both use a holistic, global processing mode, and field–independent individuals and reflective indi-
viduals both use an analytic processing mode, it would be difficult to differentiate the two cognitive styles. Huteau (1987) explained that difficulty by showing that the two styles have three components or factors in common: (a) their attention allocation behavior, which consists in going back and forth many times between the standard figure and the alternative figures, with visual field exploration being more systematic in analytic, reflective individuals; (b) they have a general intelligence factor in common; and (c) they share motivational processes related to metacognitive control.

In this study, our aim was to show that these two cognitive styles, FDI and RI, do not supply the same information about an individual’s preferred processing mode. We used two methods.

First, for the RI style, we distinguished not only reflective and impulsive individuals, but also fast-accurate individuals (short latency, high accuracy) and slow-inaccurate individuals (long latency, low accuracy). Most researchers are interested only in two of the groups—the impulsive and the reflective—because they contain the largest number of individuals (about 70%; Reuchlin, 1991) and because they support Kagan et al.’s (1964) initial hypothesis that individuals who answer too quickly (impulsivity) make more mistakes. These results show up not only as a negative correlation between these two variables, but also by the result that the correlation is high. However, there are always some individuals who take little time and make few mistakes and others who take a lot of time and make many mistakes.

Second, we measured the two cognitive styles in the same population, along with three factors that were likely to be related to them—the $g$ factor, a spatial factor, and a metacognitive control index.

We expected impulsive individuals, who should have a lower FDI score, $g$ factor, and metacognitive control index, to obtain a higher score on the spatial factor, which is based on global (analogical, holistic) information processing (Denis, 1990; Lansman, Donaldson, Hunt, & Yantis, 1982; Snow & Lohman, 1984), whereas we expected reflective individuals to obtain a high FDI score, $g$ factor, and metacognitive control index, but a lower spatial score. It is difficult to set forth any hypotheses for the slow-inaccurate and fast-accurate individuals because these two groups rarely have been studied.

Method

Participants

We tested forty-two 12- and 13-year-old seventh graders from two middle schools in the metropolitan Paris area. We acknowledge that the sample size was small.

We studied seventh graders on the basis of the differentiation–dedifferentiation hypothesis (Li et al., 2004). In that hypothesis, the authors “postulated that intel-
lectual abilities are rather undifferentiated in childhood, undergo differentiation during maturation leading to a multi-faceted ability structure that remains largely invariant during adulthood, and becomes undifferentiated again (dedifferentiation) during senescence” (p. 1). “The extent of differentiation (i.e., multiple ability dimensions) inferable from the interrelationship of the psychometric tests was estimated by the number of dominant principal components (PC) for each age group. As predicted, the estimated number of dimensions of the correlation matrix involving the 15 tests was smaller in childhood, late adulthood, and old age than in adolescence, young, and middle adulthood. The amount of variance accounted for by the first PC was larger at both ends of the lifespan and fluid and crystallized intelligence were more highly correlated in childhood, late adulthood, and old age than in adolescence, young, and middle adulthood” (p. 5). Seventh graders correspond to the age group in the differentiation phase. In this article, our objective was to distinguish four groups of individuals (reflective, impulsive, fast-accurate, slow-inaccurate) and not only the two groups of individuals (reflective, impulsive), which have been studied often when factor $g$ (fluid intelligence) explains a large part of the total variance.

Materials

We administered the MFFT to each student individually. We tested the students collectively on the Group Embedded Figures Test (GEFT; Witkin et al., 1985), a $g$-factor test developed at the Institut National d’Etudes du Travail et de l’Orientation Professionnelle (UCSWPO [National Institute of Studies on Work and Professional Orientation]; Demangeon, 1978), and a spatial abilities test (Primary Mental Abilities subtest; Thurstone & Thurstone, 1964).

We calculated a metacognitive control index from the MFFT scores (Rozencwaig, 2003). According to Flavell (1987), individuals exhibit metacognition if they are capable of adjusting their effort to the difficulty of a task. To measure this type of control, we analyzed the individuals’ behavior as they took the MFFT test. This test contains items of different levels of difficulty, but they are not presented in order of difficulty. To exercise metacognitive control, individuals do not need to know that the item is more difficult, they only need to take more time to answer. We designed the metacognitive control index to indicate whether the person’s latency increased when an objectively more difficult item was presented. This specific index is an estimate of the actual difficulty of the item (see Table 1). We called this index the metacognitive index of reactivity to task difficulty (MRD). We obtained the index for each person by calculating the correlation (Bravais–Pearson coefficient) between two series of 12 measures, which corresponded to the 12 items on the MFFT (the individual’s latency [time taken to give first response] and the median latency of individuals who succeeded on that item on the first try). To succeed on the first try, a person had to look at every one of eight figures before giving an answer. The median latency indicated the time taken to inspect all eight fig-
ures. The advantage of calculating the median rather than the mean is that the median is an indicator of a central tendency that is less sensitive to extreme values. In this way, very short or very long latencies, which are atypical, would not carry excessive weight in determining an item’s true level of difficulty.

An MRD value of +1 reflects perfect time adjustment, whereas a value of −1 reflects poor adjustment. In the example in Table 1, we obtained a positive value of .39.

### Validity Data for the Metacognitive Control Index

Metacognitive progressing is related to general intelligence. Campione (1987) showed, for example, that a group of children with mental retardation were capable of learning a strategy and retaining it in memory, but were often incapable of generalizing it for use in new situations. Campione interpreted this lack of transfer as being the result of poor development of the metacognitive processes that enable participants to become aware of, and thus monitor, their own functioning. However, the result also can be interpreted as a more general cognitive deficit. With seventh graders, the correlation between the monitoring index with a test of fluid intelligence was .64. Furthermore, the correlation between the monitoring index and fluid intelligence, with crystallized intelligence held constant, changed little and dropped only from .64 to .54 (Rozencwajg, 2003).

### TABLE 1. Latency of a Particular Participant and Median Latency of All Participants Who Answered Correctly on the First Try, for the 12 Matching Familiar Figures Test Items

<table>
<thead>
<tr>
<th>Item</th>
<th>Participants who succeeded on first try, n</th>
<th>Median latency, s</th>
<th>Participant’s latency, s</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>26</td>
<td>49.5</td>
<td>113</td>
</tr>
<tr>
<td>2</td>
<td>12</td>
<td>77.5</td>
<td>87</td>
</tr>
<tr>
<td>3</td>
<td>14</td>
<td>84.0</td>
<td>109</td>
</tr>
<tr>
<td>4</td>
<td>21</td>
<td>59.0</td>
<td>59</td>
</tr>
<tr>
<td>5</td>
<td>28</td>
<td>99.5</td>
<td>104</td>
</tr>
<tr>
<td>6</td>
<td>33</td>
<td>36.0</td>
<td>38</td>
</tr>
<tr>
<td>7</td>
<td>26</td>
<td>81.0</td>
<td>34</td>
</tr>
<tr>
<td>8</td>
<td>20</td>
<td>86.5</td>
<td>143</td>
</tr>
<tr>
<td>9</td>
<td>24</td>
<td>49.5</td>
<td>87</td>
</tr>
<tr>
<td>10</td>
<td>24</td>
<td>64.0</td>
<td>57</td>
</tr>
<tr>
<td>11</td>
<td>23</td>
<td>69.0</td>
<td>71</td>
</tr>
<tr>
<td>12</td>
<td>32</td>
<td>47.5</td>
<td>85</td>
</tr>
</tbody>
</table>

*Note.* The number of participants differs across items.
Rozencwajg (2003) showed a correlation between the monitoring index and problem strategies in physics (.43), which can be considered relatively strong (Corroyer & Rouanet, 1994). That correlation is relatively high when compared with similar studies. A tool for assessing reading metacognition was developed by Otero, Campanario, and Hopkins (1992), who related the results to scores on a test of overall academic achievement at various ages. The authors obtained correlations ranging from .15 to .41. Jacobs and Paris (1987) devised another tool for evaluating reading metacognition. They obtained correlations with a reading test ranging from .22 to .35.

Ineffective monitoring was mainly characteristic of students whose performance and conceptualization were weak. That group did not gear their resource allocation to task difficulty (the group whose monitoring index was negative). That result was consistent with the findings obtained by Fayol and Monteil (1994), who noted that weak students sense that “all efforts are useless because they think they have no control over their performance” (p. 97). Chartier and Lautrey (1992) found that those students did not apply themselves cognitively because they felt helpless.

**Results**

In addition to computing the traditional inferential statistics, which indicate whether the true population effect differs from zero, we also checked the magnitude of the effect found for each of the analyses (Wilkinson et al., 1999). We followed two steps for comparing means. At the descriptive level, we looked at the calibrated effect \((CE; CE = \text{square root } [F \times k/n])\) in which \(k\) is the number of groups and \(n\) is the number of participants). We considered the observed population effect to be small, medium, or large if the \(CE\) was less than .30, between .30 and .60, or more than .60, respectively (Cohen, 1988; Corroyer & Rouanet, 1994; Rouanet, 1996). This index is the ratio of the between-variance to the within-variance. The higher the \(CE\) is, the greater the difference of means between the groups, compared with the individual variations within each group. We tested the magnitude of the effect in the parent population (the true effect, \(d\)) by calculating the Bayesian probability \((g)\), knowing that a value of .90 (90%) is considered a sufficient guarantee (Bernard, 1998; Rouanet). For all analyses, we used PAC and LeBayesien statistical software (see www.univ-rouen.fr/LMRS/persopage/lecoutre/eris.htm).

**MFFT Results**

We divided the participants into four groups using the median as the cutoff point: (a) fast-accurate (short latency, high accuracy), (b) reflective (long latency, high accuracy), (c) impulsive (short latency, low accuracy), and (d) slow-inaccurate (long latency, low accuracy). The median of the latency scores was 61.87 s and the median of the accuracy scores was 1.62 errors.
Table 2 shows that the proportion of participants in each group is similar to that which is typically found (Reuchlin, 1991) with a high correlation (but not 1) between the latency and the number of mistakes (−.75). Latency (CE = 2) and accuracy (CE = 1.57) differed sharply in the four groups (Corroyer & Rouanet, 1994; Rouanet, 1996).

Results for the Other Cognitive Factors

As Table 3 shows, the variables clearly differentiated the participants, especially the new MRD index (metacognitive control of the solving process in the MFFT task), which spanned a large range between a negative value of −0.42 and a positive value of +0.86.

Relationships Between Variables

Table 4 presents the raw and z scores we obtained for the four groups, and Figure 1 presents a graphic representation of the z scores for the different factors, as a function of MFFT group.

**TABLE 2. Mean Latency and Accuracy in the Four Groups**

<table>
<thead>
<tr>
<th>Group</th>
<th>N</th>
<th>Latency, s</th>
<th>Accuracy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fast-accurate</td>
<td>5</td>
<td>52.1</td>
<td>1.48</td>
</tr>
<tr>
<td>Reflective</td>
<td>16</td>
<td>93.1</td>
<td>1.30</td>
</tr>
<tr>
<td>Impulsive</td>
<td>16</td>
<td>31.6</td>
<td>2.45</td>
</tr>
<tr>
<td>Slow-inaccurate</td>
<td>5</td>
<td>75.7</td>
<td>1.75</td>
</tr>
</tbody>
</table>

*Note. F(3, 38) = 41.78 (p < .0001) for latency. F(3, 38) = 26.02 (p < .0001) for accuracy.*

**TABLE 3. Values Obtained for Each Variable**

<table>
<thead>
<tr>
<th>Variable</th>
<th>Min.</th>
<th>Max.</th>
<th>M</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>FDI</td>
<td>1.00</td>
<td>18.00</td>
<td>11.62</td>
<td>4.95</td>
</tr>
<tr>
<td>g factor</td>
<td>3.00</td>
<td>15.00</td>
<td>11.29</td>
<td>3.39</td>
</tr>
<tr>
<td>MRD</td>
<td>−0.42</td>
<td>+0.86</td>
<td>+0.42</td>
<td>0.33</td>
</tr>
<tr>
<td>Spatial test</td>
<td>0.00</td>
<td>54.00</td>
<td>23.67</td>
<td>14.79</td>
</tr>
</tbody>
</table>

*Note. FDI = field dependence/independence; MRD = metacognitive index of reactivity to task difficulty.*
As we expected, reflective individuals had a higher FDI score than did impulsive ones. Moreover, Table 4 and Figure 1 show that the fast-accurate group was like the reflective group, whereas the slow-inaccurate group was like the impulsive group.

### Table 4. Mean Raw Scores (z Scores in Parentheses) for FDI, the Spatial Factor, the g Factor, and MRD, Obtained by the Four MFFT Groups

<table>
<thead>
<tr>
<th>Group</th>
<th>FDI</th>
<th>Spatial</th>
<th>g factor</th>
<th>MRD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fast-accurate</td>
<td>16.00 (+.90)</td>
<td>30.40 (+.46)</td>
<td>13.20 (+.57)</td>
<td>0.53 (+.33)</td>
</tr>
<tr>
<td>Reflective</td>
<td>13.75 (+.44)</td>
<td>20.63 (−.21)</td>
<td>13.31 (+.61)</td>
<td>0.56 (+.43)</td>
</tr>
<tr>
<td>Impulsive</td>
<td>8.94 (−.55)</td>
<td>26.50 (+.19)</td>
<td>8.94 (−.70)</td>
<td>0.22 (−.64)</td>
</tr>
<tr>
<td>Slow-inaccurate</td>
<td>9.00 (−.54)</td>
<td>17.60 (−.42)</td>
<td>10.40 (−.26)</td>
<td>0.54 (+.35)</td>
</tr>
</tbody>
</table>

*Note. FDI = field dependence/independence; MRD = metacognitive index of reactivity to task difficulty; MFFT = Matching Familiar Figures Test.*

### Figure 1. Profile (z scores) of the four groups defined by the Matching Familiar Figures Test.

**RI and FDI**

As we expected, reflective individuals had a higher FDI score than did impulsive ones. Moreover, Table 4 and Figure 1 show that the fast-accurate group was like the reflective group, whereas the slow-inaccurate group was like the impulsive group.
group. The comparison (CE, t test, g) differed from the reflective and fast-accurate groups to the impulsive and slow-inaccurate groups, $CE = .90, t(1, 38) = 3.83, p < .001$. The difference seemed to be more than about 4 points, $g(d > 3.90) = 0.90$.

**RI and the g Factor**

Similarly, the reflective group achieved a higher g-factor score than did the impulsive group. Table 4 and Figure 1 show that the fast-accurate group was like the reflective group, whereas the slow-inaccurate group was like the impulsive group. The reflective and fast-accurate individuals differed from the impulsive and slow-inaccurate individuals, $CE = 1.03, t(1, 38) = 3.56, p < .001$. The Bayesian probability was sufficiently high to guarantee a difference of more than about 3 points, $g(d > 2.72) = 0.90$.

**RI and the Spatial Factor**

For the spatial factor, we expected the reflective group to have a lower score than the impulsive group. Indeed, impulsive individuals were like fast-accurate ones in performing better than reflective and slow-inaccurate individuals. The impulsive and fast-accurate groups differed from the reflective and slow-inaccurate ones; however, the magnitude of the observed difference was moderate ($CE = .37$), and the true difference was not different from 0, $t(1, 38) = 1.75, ns, p = .09$. The difference was larger in the comparison of the fast-accurate and reflective groups ($CE = .47$), and it was smaller in the comparison of the impulsive and reflective groups ($CE = .28$). These results can be interpreted in terms of effective processing (here, use of the holistic process in the spatial test), which required a certain level of general intelligence. When all participants whose general intelligence test score was more than 1 standard deviation below the mean were withdrawn from these two groups (impulsive, reflective), the results were different (see Table 5). In particular, the magnitude of the difference became greater ($CE$ rose from .28 to .63), and the true effect differed from 0, $t(1, 23) = 2.23, S, p = .04$.

**RI and Metacognitive Control**

We expected reflective individuals to perform better than impulsive individuals on the metacognitive control index. We found that the reflective group was similar to the fast-accurate and slow-inaccurate groups, but they were all different from the impulsive group. Impulsive individuals were different from the other three groups. The slow-inaccurate individuals obtained poor scores on all tests except metacognitive control, $CE = .80, t(1, 38) = 3.30, p = .0001$. The Bayesian probability was sufficiently high to guarantee a difference of more than .20 points, $g(d > 0.20) = 0.90$. MRD is a correlation coefficient, and a difference of .20 can be regarded as large.
From the standpoint of the processes implemented, one can therefore conclude that:

1. Reflective individuals tended to use an analytic process, which they were capable of implementing (FDI+, \( g^+ \)) and which they controlled well (MRD+), but holistic processing was not their preferential mode (S\( ^- \)).

2. Fast-accurate individuals seemed to be capable of implementing both analytic (FDI+) and holistic (S+) processes, and they exhibited cognitive maturity (\( g^+ \), MRD+).

3. Impulsive individuals lacked cognitive maturity (\( g^- \), MRD\( ^- \)) and tended to prefer holistic processing (S+) over analytic processing (FDI\( ^- \)). The use of a holistic process nevertheless seemed to require an adequate level of general intelligence.

4. Slow-inaccurate individuals adjusted their response latency to the difficulty of the task. In this respect, they were like the reflective and fast-accurate groups and unlike the impulsive group (MRD+). They were still unable to achieve adequate analytical (FDI\( ^- \)) or holistic (S\( ^- \)) processing.

**Discussion**

Consistent with the results of previous researchers (Borkowski et al., 1983; Lawry et al., 1983) and with Ancillotti’s hypothesis (1984, 1985), reflective individuals seemed to exhibit cognitive maturity and a preference for analytic processing. These cognitive processes are unlike those of impulsive individuals, who seemed to lack cognitive maturity and showed a preference for holistic processing. Thus, we only partly validated the hypothesis of Zelniker et al. (1977)—impulsive individuals preferred holistic processing and exhibited normal cognitive maturity. Their privileged process was indeed holistic, but it was associated with insufficient cognitive maturity. Moreover, when the general intelligence level of the impulsive individuals was too low, we did not observe their superiority in holistic processing. In other words, holistic processing seemed to be possible only if they had reached a certain level of general intelligence. On the basis of these results, we hypothesized that general intelligence and information-processing

<table>
<thead>
<tr>
<th>Group</th>
<th>n</th>
<th>Spatial test score</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reflective</td>
<td>15</td>
<td>20.73</td>
</tr>
<tr>
<td>Impulsive</td>
<td>10</td>
<td>33.20</td>
</tr>
</tbody>
</table>
preferences (i.e., cognitive styles) were only partially independent (Tucker & Warr, 1996; Zhang, 2002). One way to gain further insight into the solving modes of impulsive individuals would be to record their eye movements to observe whether they looked quickly (too quickly) at all eight figures in the MFFT or whether they simply gave the first answer that seemed correct without making a thorough inspection. This approach could be used with the MFFT of Kagan et al. (1964) and also with Zelniker and Jeffrey’s (1976) global version of it.

In support of Huteau’s (1987) hypothesis, reflective individuals and impulsive individuals were different from each other when it came to metacognitive control of problem solving, which was good for the former and bad for the latter. Fast-accurate individuals achieved a high performance level (short latency accompanied by few mistakes) because they seemed capable of analytic and holistic processing. Slow-inaccurate individuals were doubly jeopardized by their deficient processing in both modes. They proved capable of adjusting the time spent on a problem to its level of difficulty (high metacognitive control index) but to no avail. These participants apparently exerted proper metacognitive control over task execution but lacked the ability to implement an analytic process on the MFFT.

The distinctiveness of the conclusions emerges only when all five of the indexes are considered. In other words, a single factor cannot explain cognitive functioning. These results support the model of integrative intelligence, which was developed by Rozencwajg (2005).

Our findings can be conceptualized in terms of the vicariante process model, which showed that different individuals may implement different cognitive strategies to solve a given task, depending on their preferential information-processing mode (Reuchlin, 1978). It seems that some individuals (fast and accurate ones) benefit from equal accessibility of analytic and global processes.

NOTE

1. We considered FDI to be the ability to master embedded contexts, not a way of weighing visual, postural, and labyrinthine information in certain perceptual situations (see Huteau, 1987). Because of this restriction, we assessed FDI using the GEFT.

REFERENCES


*Received April 5, 2005*