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Measuring both systems of reasoning: a study of the predictive capacity of a new version of the Rational-Experiential Inventory

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Previous research on the Rational-Experiential Inventory (REI; Epstein, Pacini, Denes-Raj and Heier, 1996) has produced inconsistent results concerning its predictive validity with specific reasoning tasks. To evaluate the predictive capacity of the REI in greater detail we used ten tasks requiring different types of reasoning (e.g., deductive and probabilistic). The latest version of the REI (Pacini and Epstein, 1999) was adapted to Spanish and answered by 120 participants. Findings suggest that thinking styles of processing as measured by the REI reflect the existence of individual differences, but that its predictive capacity is limited to some particular reasoning tasks. Some explanations for these limitations are discussed within the context of dual-reasoning theories.

Keywords: Reasoning, thinking styles, Rational-Experiential Inventory, Cognitive-experiential self-theory, experiential system, analytical system.

Midiendo ambos sistemas de razonamiento: un estudio de la capacidad predictiva de una nueva versión del Rational-Experiential Inventory. La investigación previa con el Rational-Experiential Inventory (REI; Epstein, Pacini, Denes-Raj y Heier, 1996) ha producido resultados inconsistentes en cuanto a la validez predictiva con tareas de razonamiento específicas. Para evaluar la capacidad predictiva del REI con mayor detalle se utilizaron diez tareas que requieren diferentes tipos de razonamiento (e.g. deductivo y probabilístico). La última versión del REI (Pacini y Epstein, 1999) fue adaptada al español y presentada a 120 participantes. Los resultados muestran que los tipos de razonamiento como son medidos por el REI la existencia de diferencias individuales, pero su capacidad predictiva está limitada a algunas tareas de razonamiento. Algunas explicaciones de las limitaciones se discuten en el contexto de las teorías de los dos sistemas de razonamiento.

Palabras clave: Razonamiento, estilos de pensamiento, Rational-Experiential Inventory, Cognitive-experiential self-theory, sistema experiencial, sistema analítico.

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In recent decades, researchers working on human reasoning have proposed the existence of two systems of reasoning, experiential and analytical. Although there are different proposals regarding the nature of these two systems, numerous similarities also exist (e.g., Epstein, 1994; Evans and Over, 1996; Sloman, 1996). It is argued that both systems perform together in a parallel and interactive way, although there is a relative dominance of one system over the other. According to Cognitive-Experiential Self-Theory (CEST; Epstein, 1994), some people make greater use of the experiential style while others prefer the analytical one, and this means there are different cognitive profiles depending on the use of the two systems.

Within the CEST framework, Epstein, Pacini, Denes-Raj and Heier (1996) developed the Rational-Experiential Inventory (REI), a self-report measure to test individual differences in thinking styles (analytical and experiential). It is divided into two unipolar scales (twenty items each) designed to measure both styles of thinking. The analytical scale, a reduced version of Need for Cognition (NFC; Cacioppo and Petty, 1982), measures levels of engagement and enjoyment with respect to intellectual experiences and logical-statistical processing. Therefore, it is relevant for the measurement of analytical reasoning (e.g., "I enjoy solving problems that require hard thinking"). The experiential scale, known as Faith in Intuition (FI; Epstein *et al*., 1996) measures levels of engagement and relies on intuition and first impressions (e.g., "I believe in trusting my hunches"). The latest version of the REI (Pacini and Epstein, 1999; the version used in this study) includes two subscales: a) ability, which measures confidence in capacities; and b) engagement, to measure the level of utilization, pleasure and positive attitudes. Moreover, some of the items are written with a positive orientation (e.g., "Learning new ways to think would be very appealing to me") and others with a negative orientation (e.g., "I am not very good at solving problems that require careful logical analysis"). To date, accumulated evidence shows that the latest version of the REI has good psychometric properties. The validation of the REI in Spanish and its psychometric features are reported in Sánchez, Fernández-Berrocal y Alonso (in preparation).

In contrast to psychometric research, predictive validity studies have provided contradictory results. Studies that relate REI with performance on reasoning tasks have not always yielded results in accordance with CEST predictions. Pacini *et al.* (1999) worked with the ratio-bias and found that the relationships between task performance and the REI are not direct, as CEST predicts. Only NFC was related negatively to heuristic processing (non-optimal answers). In fact, these authors suggest that the relationships between the REI and reasoning tasks change depending on the type of processing involved. Shiloh and colleagues (Shiloh, Salton and Sharabi, 2002) drew a similar conclusion. Using decision-making tasks under conditions of uncertainty (e.g., Asian disease problems and problems with equal expected-value answers) they

found that pure styles (e.g., very intuitive) were not related to task performance, but were weakly related to a combination of the styles (e.g., very analytical and very intuitive). Shiloh *et al.* (2002) acknowledged the difficulty of generalizing the results and suggested that it was due to the narrow margin of task types used.

Newstead, Thompson and Handley (2002) studied the relationships between the REI and two different types of task: generation of alternative graphs from two premises and syllogistic reasoning tasks. Only three significant correlations were found: between FI and the inability to falsify conclusions, and between NFC and two indices of the production of alternative representations. Alonso and Fernandez-Berrocal (2003) found that correct answers to problems that are prone to ratio-bias were not related to high scores on the NFC, and neither was non-optimal answers related to low scores on it.

Newstead, Handley, Harley, Wright and Farrelly (2004) found the REI to be a poor predictor of performance on different versions of the Wason selection task (WST); those trends which were observed were not significant. Participants in the FI's highest quartile tended to produce few correct answers on the indicative version of the WST, whereas the same group produced more correct answers with the deontic version. In contrast, Naito, Suzuki and Sakamoto (2004) studied probabilistic-reasoning problems prone to conjunction fallacy (e.g., Linda task) and obtained results in line with CEST predictions. Participants with low scores on the FI scale produced low mistake frequencies compared with those who scored high. Furthermore, subjects who scored high on the NFC made fewer mistakes than those who obtained low scores. In short, although the psychometric characteristics have systematically appeared to be good, predictive validity shows unclear and divergent results.

The present study aimed to evaluate in greater detail the predictive validity of the REI using a relatively broad set of reasoning tasks, including logical-deductive and probabilistic reasoning tasks, and an insight problem (see materials and Annex I). Thus, we sought to go beyond those studies that used isolated tasks or tasks of the same kind. Consequently, we also hoped to determine whether the poor predictive validity of REI was indeed due to the narrow margin of tasks studied, as suggested by Shiloh *et al.* (2002).

Based on CEST, it was expected that subjects who gave normative responses would produce higher scores on NFC than those who gave heuristic responses, and/or that the former would score low on the FI in comparison with the latter.

METHOD

Participants

120 students from the University of Almeria: 101 women, 18 men and a participant who did not specify his/her gender. The average age was 23.2 years (SD=4.20); for women 23.17 (SD=4.72) and for men 23.41 (SD=1.90).

Materials

Reasoning tasks. We selected two tasks about deductive reasoning (7 and 10), seven about probabilistic reasoning (1, 2, 3, 4, 5, 6 and 8) and one in the form of an insight problem (9). These tasks were designed to enable a distinction to be made between normative and heuristic (if this is the case) answers. Except for 7, 8 and 9, all tasks had three possible answers (see Annex I).

Rational-Experiential Inventory. Starting from the latest version of the REI (Pacini and Epstein, 1999) a reduced version was produced. After factor analysis, the inventory was purified by eliminating items with a correlation lower than 0.40 with the factor to which they belonged. Twenty-nine items made up the reduced version: 13 from NFC (reliability, $\alpha = 0.87$) and 16 from FI ($\alpha = 0.89$). With the reduced version two main factors emerged, accounting for 42.8% of the variance; there was no correlation between the two scales (-0.02, n.s.). Annex II shows the original forty REI items and those which were eliminated to produce the reduced version used in this study (for more details see Sánchez, Fernández-Berrocal and Alonso, in preparation).

Procedure

In a single session participants responded to the latest version of the REI and then performed the reasoning tasks. REI items and tasks were presented in the order shown in Annex I and Annex II.

RESULTS

REI scores of items with a negative orientation were transformed by applying the equation: New score = 6 - direct score. Thus, the higher the score the more a given reasoning style was present. For each task two variables were generated. For the first, one point was assigned when the response was normative, and zero in any other case. Similarly, for the second variable, one point was assigned if the response was heuristic (tasks 1, 2, 3, 4, 5, 6, and 8), and zero in any other case.

Table 1 shows the percentages of participants who produced normative responses (NR) and those who generated heuristic responses (HR). It also shows NFC and FI averages for both groups (normative and heuristic responders). Gender differences were not significant for any REI scores, and were thus neither presented nor taken into account for further analyses.

Three tasks yielded results in accordance with hypotheses about the predictive capacity of the REI: these were 4, 6, and 10. First, in task 6, those who produced NR scored significantly higher on NFC than did those who produced HR (see Table 1). This suggests that those who score higher on NFC have a greater probability of generating NR. Secondly, for two tasks the predictive capacity of the REI showed differences close

to the significance criterion: these were task 4 (FI scale), which requires overcoming a belief in order to produce the normative answer, and task 10 (NFC scale), which belongs to the deductive reasoning field. Task 5 presented an opposite significant relationship with NFC and FI. Participants who answered this task correctly scored significantly higher on FI and lower on NFC than did those who solved it incorrectly (see Table 1). No relationships were found between scales and problems 1, 2, 3, 7, 8, and 9.

Table 1. Task performance and average of REI scales

Task	Percentage (number of participants)		Need For Congtition					Faith in Intuition				
			Normative Response		Heuristic Response			Normative Response		Heuristic Response		
	Normative Response	Heuristic Response	M	SD	M	SD	t	M	SD	M	SD	t
1	34 (41)	59 (71)	3.43	0.72	3.39	0.49	0.27	2.66	0.74	2.77	0.62	-0.9
2	23 (28)	40 (48)	3.42	0.53	3.55	0.58	-0.93	2.86	0.63	2.70	0.65	1.03
3	35 (42)	48 (57)	3.42	0.61	3.37	0.55	0.41	2.75	0.71	2.70	0.63	0.33
4	16 (19)	48 (58)	3.52	0.56	3.43	0.6	0.52	2.47	0.6	2.77	0.69	-1.66†
5	18 (22)	65 (78)	3.28	0.71	3.50	0.49	-1.66†	2.99	0.7	2.64	0.64	2.19*
6	79 (95)	16 (19)	3.51	0.5	3.22	0.63	2.17*	2.74	0.68	2.65	0.57	0.53
7	50 (60)	50 (60)	3.40	0.62	3.45	0.52	-0.48	2.77	0.62	2.70	0.69	0.52
8	32 (38)	68 (82)	3.48	0.59	3.40	0.57	0.77	2.82	0.76	2.70	0.61	0.9
9	5 (6)	95 (114)	3.30	0.78	3.43	0.56	-0.52	2.69	0.54	2.74	0.66	-0.16
10	72 (86)	28 (34)	3.49	0.52	3.27	0.66	1.89†	2.76	0.66	2.67	0.65	0.68

Note. Degrees of freedom ranged form 74 to 118.
* $p < 0.05$. †$p < 0.10$, all two tailed

DISCUSSION

The present research aimed to evaluate the predictive validity of the REI in greater detail than previous studies by considering its relationships with normative-statistical or heuristic responses to a relatively wide range of reasoning tasks.

As in previous research, the present study reveals limitations to the predictive capacity of the REI. Six out of 10 tasks showed no relationship with the instrument. On the one hand, there are few clear patterns: one deductive task (10) was related to the REI but the other one (7) was not; two probabilistic tasks (5 and 6) showed relationships but the rest (1, 2, 3, and 8) did not; one of the problems prone to gambler's fallacy (6) showed a relationship but the other (1) did not; this was also the case with problems related to ignorance of sample size (with tasks 5 yes, but not with 2), as well as with problems that require the subject to overcome prior beliefs (not with tasks 3 and 8, but yes with task 4). Furthermore, the REI did not predict problems that imply a representativeness heuristic (1, 3, and 8) and conditional reasoning (task 7; Newstead *et al.* (2004) also failed to find relationships between the REI and conditional reasoning tasks). In the case of task 8, the REI did not predict answers, although Naito *et al.* (2004) reported a relationship between the REI and the same problem.

As we observed with task 5, Klaczynski, Fauth and Gordon (1997) also found that the REI predicts biases in reasoning according to the law of large numbers. The unexpected direction of relationships could be related to limitations of the REI in terms of measuring reasoning correctly (see below), and/or, as Sedlmeier and Gigerenzer (2000) suggested, it could be that participants thought experientially based on the intuition that larger samples are closer to population and thus it can be assumed that they are close to 50%; consequently, the small hospital is more likely to have a proportion of male births of 60% or greater. Task 2, which is of the same kind as task 5, also showed the same phenomena although results were not significant. There were higher scores on FI for those who answered normatively and higher scores on NFC for the HR group.

Accumulated evidence, including both student and non-student populations (Handley, Newstead and Wright, 2000) and in different languages, English (Newstead *et al.*, 2004), Japanese (Naito *et al.*, 2004), Hebrew (Shiloh *et al.*, 2002) and Spanish (in this research), show that the REI is not a universal tool for measuring individual differences in reasoning styles, as initially was intended. However, because of its relationship with other instruments (see, for example, Pacini and Epstein, 1999), its reliability, factorial structure and relationship to certain problems, it may measure one or more aspects of cognitive activity during reasoning. This implies that the limited predictive validity of the REI was not due to the narrow margin of tasks used before (Shiloh *et al.*, 2002).

It is important to highlight that, in line with our hypotheses and other research, the relationships between problems and scales are not symmetrical. The REI consists of two complementary scales and unipolar items; therefore, they do not establish symmetrical relations with other variables, as would happen if the scales were opposing and equivalent (i.e., bipolar). Thus, the findings related to task 5 and the NFC and FI were not expected. In spite of this, and the limited experimental relationships, we believe that this is the correct way to measure both systems (two unipolar scales).

There are two inherent problems in measuring experiential system activity. One refers to the implicit complexity of measuring experiential-system processing by means of a self-report tool. According to CEST, experiential system activity occurs through unconscious processes. Therefore, if this is true, important distortions may be generated when trying to verbalize these processes via a self-report questionnaire. Another complex aspect is that the experiential system operates under very specific contextual situations, which vary depending on the individual's experience and education (Epstein *et al.*, 1996). Therefore, it could be that the contexts constructed in reasoning tasks used for this research are not that relevant for some participants. Additionally, it is possible that the experiential system could be a set of systems, as Evans (2003) suggests, and that the REI focuses mainly on one of the systems and/or on some particular aspects of them.

It should be mentioned that the experiential section (FI) was constructed to complement NFC (Cacioppo and Petty, 1982). According to the literature, the process to construct FI "took place informally over several years" (Epstein *et al.*, 1996, p. 392), and although in the latest version (Pacini and Epstein, 1999) some improvements were incorporated, it still seems insufficient. Indeed, there are important asymmetries between the scales: FI presents some errors and characteristics that NFC does not have; FI contains items with non-exhaustive answers (items 6, 25 and 26), equivalent items (32 and 33), items with questions written in conditional style (12 and 29), items not worded in the first person (25), items that imply value judgments (6, 32, and 33) and items that refer to third persons (36 and 37); furthermore, and in contrast to what the authors of the pioneering REI research intended (Epstein *et al.*, 1996, p. 392), there is a bipolar item (40), unlike the rest which are unipolar. NFC items have none of the above mentioned features. Moreover, FI has low proportions of items that imply effectiveness (4 out of 20 *vs*. 7 out of 20 in NFC) and pleasure (2 *vs*. 6 in NFC), and items that refer to general reasoning rather than address reasoning toward specific things (6 in FI and 11 in NFC). Thus, FI is asymmetric to NFC in terms of wording and the proportion of the different kinds of items. As a whole, it is highly probable that these differences produce limitations in the efficiency (variance explained by the factors and differences in the scores of both scales in people who answer normatively and heuristically), generate distortions (opposite relations, as in task 5), and, therefore, affect the generalization of results.

The REI seeks to measure analytical or experiential reasoning by means of what subjects say about beliefs of personal levels of use, confidence and preference. This assumes that people with developed cognition are capable of exploring systematically their thoughts and their efficiency (metacognition). Therefore, if skill in using a type of reasoning is developed, there are beliefs and values in favour of them. It is then assumed that types of information processing are linked to the confidence in them and beliefs regarding their use. That is to say, the desire, disposition and preference to process analytically are linked to normative performance, while disposition and preference to use intuition and other experiential processes are linked to biases and uses of heuristics. In people with advanced cognitive development (i.e., adults) it is possible to expect this. However, even if beliefs and values favour these types of reasoning, this does not necessarily imply that there are developed skills, that they are used (correctly), and that the person is aware of them. Therefore, it is necessary to determine the extent to which REI measurements represent cognitive profiles (intensity of use of both types of processing) or simply reflect a disposition toward them.

Thus, in terms of future research it may be useful: a) to ask for justification of the answers to problems in order to be able to observe the reasoning used; b) to promote the use of a particular system; c) to ask from different perspectives: perspective of a

completely logical person, perspective of other people, and personal perspective (Alonso and Fernández-Berrocal, 2003; Klaczynski, Fauth and Swanger, 1998); d) to study relationships between the REI and problems of another kind not yet studied (e.g., problems of counterfactual reasoning); e) to eliminate and add new items that complement those which work (such as General Decision-making Style and Thinking Styles Inventory, respectively: Thunholm, 2004; Zhang, 2005); and f) it could also be worth studying different cognitive profiles (e.g., analytical high and low experiential) in greater depth.

Finally, two limitations of this study should be addressed. One is the impossibility of observing the reasoning used, as participants were not asked to justify their answers to the tasks. Thus, it is not possible to see clearly the type of reasoning that the REI predicts. The only evidence is the choice of answer, which could be honestly solved or answered without care. Another important limitation (and one which also seems to affect cited studies) is that it is implicitly assumed that only the analytical system produces correct reasoning, or the experiential system only produces biases reported in the literature. Mistakes are made using the analytical system, while the experiential system may produce biases other than those which have been identified. This poses the challenge of designing tasks where it is possible to distinguish which system tries to answer regardless of whether the task was performed correctly or not (in the case of analytical processing) or if it fits with known heuristics and biases (in the case of experiential processing).

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ANNEX I

Reasoning tasks

1. Lottery tickets

You have the possibility to choose between two lottery tickets: 111111 and 487569. Which one would you buy?

-First

-Second [Heuristic answer, HR]

-Either of the two [Normative answer, NR]

2. Basketball shots

Two basketball players want to demonstrate who the best scorer is and decide to play a set of three-point shots. However, they do not know whether they should choose a set of 6 or 18 basketball shots. What should the best player choose?

-6

-18 [NR]

-Either of the two [HR]

3. Teacher Laura

Laura is attractive, elegant and polite, dresses well and goes to the hairdresser's every week. Which of the following statements is more probable?

-Laura is a college teacher

- Laura is a model [HR]

- Laura is an office worker [NR]

4. Relationship between accidents and alcohol consumption

The following study shows relationships obtained for two variables in a hypothetical sample: drinking alcohol and car accidents.

Table Annex I. Relationship between accidents and alcohol consumption

	Having an accident	Not having an accident
Drinking alcohol	12	2
Not drinking alcohol	10	0

The table shows that alcohol drinkers have proportionally…

-More car accidents than those who do not drink alcohol [HR]

-Fewer car accidents than those who do not drink alcohol [NR]

- The same number of accidents as those who do not drink alcohol

5. Percentage of births

A certain town is served by two hospitals. In the larger hospital about 100 babies are born each day, and in the smaller one about 10. Although the overall proportion of males born is about 50%, the real proportion on a particular day could be bigger or smaller than 50%. At the end of a year, which of the two hospitals would have more days with a proportion of male births greater than 60%?

-The bigger hospital

-The smaller hospital [NR]

-The number of days will be about the same [HR]

6. Sequence of coins

Imagine that you toss an honest coin 6 times and you obtain the following sequence: CXXXXX (C = Head; X = Tail). If you toss the coin again, what are you most likely to get?

-Head [HR]
-Tail
-Either of the two [NR]
7. Conditional modus tollens
If there is a white figure on a table, then there is a circle.
On the table there is no circle. Is there a white figure on the table?
-Yes
-No [NR]
-It is not possible to know with certainty
8. Rose: bank teller
Rose is 31 years old, single and is an open girl and very happy. She graduated in philosophy. When she was a student she was very committed to anti-discrimination politics and social justice, and she also used to take part in antinuclear demonstrations. What do you believe she probably is?
- She is a bank teller [NR]
-She is a bank teller and is involved with feminism [HR].
9. Insight
A stranger goes to the museum director and offers him an ancient bronze coin. The coin seemed to be authentic and the date of 544 BC was marked on it. As it happens, the director had previously acquired objects of suspicious origin, but this time he rapidly calls the police, who stop the stranger. Why?
10: Exclusive disjunction
Juan is sick or Maria has gone shopping, but not both things.
Juan is not sick. What conclusion follows?
-Maria has not gone shopping
-Maria is sick
-Maria has gone shopping [NR]

ANNEX II. *Table Annex II*. REI items

Order, scale and subscale	Item
1.NFC-A	I am not a very analytical thinker
2.NFC-A	I am much better at figuring things out logically than most people*
3.NFC-A	Using logic usually works well for me in figuring out problems in my life
4.FI-A	I believe in trusting my hunches
5.NFC-E	I don't like to have to do a lot of thinking
6.FI-E	I think there are times when one should rely on one's intuition
7.NFC-A	I am not that good at figuring out complicated problems
8.NFC-E	Thinking is not my idea of an enjoyable activity
9.FI-A	I don't have a very good sense of intuition*
10.NFC-A	Reasoning things out carefully is not one of my strong points
11.NFC-E	I try to avoid situations that require thinking in depth about something
12.FI-A	When it comes to trusting people, I can usually rely on my gut feelings
13.NFC-E	Learning new ways to think would be very appealing to me*
14.NFC-E	I enjoy intellectual challenges
15.NFC-E	Knowing the answer without having to understand the reasoning behind it is good enough for me*
16.NFC-E	Thinking hard and for a long time about something gives me little satisfaction
17.NFC-A	I am not very good at solving problems that require careful logical analysis
18.FI-A	I hardly ever go wrong when I listen to my deepest gut feelings to find an answer
19.NFC-A	I usually have clear, explainable reasons for my decisions*
20.FI-A	I can usually feel when a person is right or wrong, even if I cannot explain how I know
21.FI-E	I like rely on my intuitive impressions
22.NFC-A	I don't reason well under pressure*
23.FI-A	Using my gut feelings usually works well for me in figuring out problems in my life
24.NFC-E	I prefer complex problems to simple problems
25.FI-E	Intuition can be a very useful way to solve problems
26.FI-E	I often go by my instincts when deciding on a course of action
27.FI-A	I trust my initial feelings about people
28.NFC-A	I have no problems thinking things through carefully*
29.FI-A	If I were to rely on my gut feelings, I would often make mistakes
30.FI-E	I don't like situations in which I have to rely on intuition
31.NFC-E	I enjoy thinking in abstract terms
32.FI-E	I think it is foolish to make important decisions based on feeling
33.FI-E	I don't think it is a good idea to rely on one's intuition for important decisions
34.FI-E	I generally don't depend on my feelings to help me make decisions
35.NFC-A	I have a logical mind*
36.FI-E	I would not want to depend on anyone who described himself or herself as intuitive*
37.FI-A	My snap judgments are probably not as good as most people's*
38.FI-E	I tend to use my heart as a guide for my actions
39.NFC-E	I enjoy solving problems that require hard thinking
40.FI-A	I suspect my hunches are innacurate as often as they are accurate*

Scales: NFC (Need for Cognition) and FI (Faith in Intuition).Subscales: A (Ability) and E (Engagement)
Items with "*" were not used for analyses presented (for more details see Sánchez, Fernández-Berrocal & Alonso, in preparation).

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