

WAYS OF THINKING: THE EFFECT OF PERSONALITY ON REASONING

Ascensión Fumero¹, Carlos Santamaría¹ and Philip Johnson-Laird²

¹University of La Laguna and ²Princeton University

This paper presents a study for testing the idea that personality affects the way people reason in a predictable way. That is, traits might affect the particular possibilities that individuals envisage, and in turn, influence the way they reason. Different traits, as we have shown, can elicit different ways of thinking, and consequently individuals would reason better in the field pertinent to their personality. We applied to 94 participants the NEO-PI-R personality test and a conditional inference task designed on the basis of the NEO-PI-R items. We found, in general, that our participants reasoned better (higher rate of Modus Tollens) with the material related to the personality trait on which they scored highest. Also those participants scoring high in Extraversion or Neuroticism made more valid inferences than those who scored low in the same trait for the items related to their personality. These results are in accordance with the principle of inferential consequences and the Mental Model Theory of Reasoning.

Este artículo presenta una investigación que trata de poner a prueba la idea de que la personalidad afecta a la forma de razonar de las personas de una manera predecible. Es decir, los rasgos influirían en las posibilidades particulares que los individuos imaginen y podrían cambiar la forma en que razonan. Encontramos parcialmente confirmada la hipótesis. Diferentes rasgos dieron lugar a distintas formas de pensar, lo que tuvo como consecuencia que en ciertos casos los participantes razonaron mejor en los campos pertinentes a su personalidad. 94 participantes fueron evaluados con el NEO-PI-R y realizaron una tarea de inferencias condicionales diseñada a partir de los ítems de dicha prueba de personalidad. Encontramos que nuestros participantes razonaron globalmente mejor (mayores tasas de Modus Tollens) cuando los materiales estaban relacionados con la característica de personalidad en la que puntuaban alto. Además, los participantes que puntuaron alto en Extraversión o Neuroticismo produjeron más inferencias válidas en los ítems relacionados con su personalidad que aquellos que puntuaron bajo en el mismo rasgo. Estos resultados son acordes con el principio de consecuencias inferenciales y la teoría de Modelos Mentales en razonamiento.

People receive information from the outside world in a wide variety of formats, and on the basis of it we sometimes change our beliefs. We thought swans were always white, or that newspapers always told the truth, until we came across exceptions. Mediating between the appearance of the case (the exception, for example) and the change in beliefs is a genuinely human capacity: reasoning (see Harman, 1986). The role of reasoning in the way we categorize and interpret the world is of unquestionable importance. However, the classic perspective on reasoning conceives of it as a formal ability unconnected to the content to which it is applied (Braine & O'Brien, 1991; Inhelder & Piaget, 1955; Rips, 1994). From this perspective we would not expect reasoning processes to vary qualitatively from one person to another. Rather, it is assumed that all

human beings would use the same set of rules for reasoning, just as the speakers of a shared language interpret the syntactic constructions of that language in the same way. If a verb is in the past for all those who hear it and know the language, a valid inference would be valid for whoever.

An alternative to this conception of reasoning is the idea that the reasoning process itself is based on the generation and manipulation of the possibilities compatible with the premises and with one's general knowledge (Johnson-Laird, 2006). Accordingly, people would form models of consistent situations and could operate with these models in order to reach conclusions. Errors of reasoning would often derive from the fact that limitations in our working memory oblige us to consider, not all the possibilities actually compatible with a premise, but only a subset of them (García Madruga, Gutiérrez, Carriedo, Vila, & Luzón, 2007). Obviously, an expert in a certain field will be more likely to take into consideration the pertinent possibilities.

The original Spanish version of this paper has been previously published in *Psicothema*, 2010, Vol. 22, No 1, 57-62

.....
Correspondence concerning this article should be addressed to Ascensión Fumero. Facultad de Psicología. Universidad de La Laguna. 38205 La Laguna. Spain. E-mail: afumero@ull.es

Arising from this idea is a curious prediction: people suffering from certain mental disorders will, in some cases, turn into expert reasoners in the field of their disorder. For example, a hypochondriac would take into account more possibilities in a problem related to illnesses than a person without such an affliction. What is most striking about this hypothesis is that it contradicts the classical point of view in cognitive psychopathology, which is precisely that mental disorders are the result of limitations in reasoning (Beck, 1976). The testing of this hypothesis led to Johnson-Laird, Mancini and Gangemi's (2006) *hyper-emotion theory* of mental disorders. This theory postulates that such disorders have their origin in a cognitive assessment which results in a series of unconscious transitions giving rise to a basic emotion. This emotion is appropriate for the situation (it is not in the strict sense irrational) but is excessive in its intensity. The theory proposes five basic principles, though for the purposes of our research we shall focus only on the fifth, which postulates that individuals can reason anomalously about their emotions and their causes. The consequences of this anomalous reasoning would include an increased emotional response that can lead to specific behaviours in situations which provoke anxiety, and also the development of characteristic reasoning patterns in individuals depending on the nature of their disorder.

It is not only to be expected that individuals with psychological disorders will become expert reasoners; also, in a more general context, people will tend to take into account one possibility or another according to their personality. Thus, the most extravert will consider possibilities referring to social relations; the most neurotic, those referring to anxiogenic situations. In order to develop this prediction we took as a starting point the fifth principle of the hyper-emotion theory, the *principle of inferential consequences*. This principle can be directly adapted to the field of personality: individuals characterized by specific personality features will show better reasoning about those topics associated with their most relevant personal characteristics, and will emerge as expert reasoners in that field. The principle, then, permits us to predict that a person's reasoning on a matter related to their specific temperamental characteristics may be better than that of other individuals with different characteristics about the same topic and than their own reasoning about other matters.

In a recent work we were able to demonstrate the influence of personality variables on the type of reasoning

people use (Fumero, Santamaría, & Johnson-Laird, Laird, 2010). Specifically, people with more openness to experience preferred to perform explanatory inductions, rather than deductions, in a task that permitted both types of response. Induction being a type of inference that increases semantic information and requires some creative contribution from the individual, their personality led them to use it more frequently than deduction, which is a surer but less informative inference.

The goal of the present work is to carry out an exploratory study with a view to testing the following general hypothesis: there is a relationship between percentage of valid conditional inferences and personality profile when the content of the inferences is related to that profile. To this end we prepared a booklet with conditional inference problems referring to the fields most closely related to the factors and applied it to the participants (previously assessed in personality) in order to test the hypothesis that people will reason better in those contexts most closely related to their personality.

METHOD

Participants

Ninety-four students from the University of La Laguna, whose participation was voluntary.

Instruments

- ✓ NEO-PI-R (Costa & McCrae, 1999): this comprises 240 items, whose response format is Likert-type with 5 options. It assesses five basic personality dimensions: Neuroticism, Extraversion, Openness to experience, Agreeableness and Conscientiousness. The replication of the five-factor structure in various languages and cultures (McCrae & Terracciano, 2005) has demonstrated its construct validity. The Spanish version has shown satisfactory psychometric properties, with stability coefficients ranging from 0.91 to 0.82.
- ✓ A booklet was prepared with 12 self-referential inference problems. For writing the problems we selected a series of items from each one of the NEOPI-R factors. On selecting the items we took into account that they must be able to be proposed in the conditional, that is, in the form "If... then..." Some of the items were slightly modified to remove adverbs and modals, such as "sometimes" or "possibly," and explicit negations, since all of this could interfere with the logic of the conditional. For example, the item: "When I'm under severe stress I feel I'm going to break down"

from the Neuroticism factor was reformulated as “If I’m under severe stress I feel I’m going to break down.”

Each booklet contained 12 problems, four of which referred to the factor in which the participant scored highest and four to the factor in which they scored lowest. The other four were control problems in which it was assumed that the topic was not related to the personality characteristics. Each of these three blocks contained problems drawn up using the two basic types of inference: Modus Ponens (MP) and Modus Tollens (MT). The problems, moreover, were formulated in such a way that they were favourable or unfavourable to the factor in question. That is, we used as a basis for writing them items that correlated either positively or negatively with the trait or factor in question. In the case of the control problems we used the criterion of “believable” or “unbelievable.” Examples of the formulation of each type of problem are shown in Table 1.

Procedure

Participants had filled out the NEOPI-R previously as a class activity to obtain their own personality profile. Scores were standardized for revealing at an individual level the factors in which they scored highest and lowest. Each participant received a booklet specifically combining his or her most extreme personal characteristics – those in which they scored highest and lowest –, together with the same number of control problems, all presented in random fashion.

Design

Participants were given a booklet containing a reasoning test. The booklet included a total of 12 inference problems. Each one of the booklets resulted from the application of the following 2x2x3 design: proposal of the problems following a type of inference in Modus Ponens or Modus Tollens, item that correlated positively or negatively with the corresponding personality factor, and a combination of the following: item referring to the trait on which the person scored highest; item referring to the trait in which he/she scored lowest (this is the only repeated factor between groups); and control problems not directly related to personality characteristics. The four control problems were designed for both types of inference, but in these problems the consideration of positively/negatively correlated with the personality trait was modified so that they were classified as believable or unbelievable.

Data analysis

The analyses were carried out using the SPSS statistical package, version 15.0 for Windows. Comparisons of means were carried out using Student’s *t* for comparing the percentages of valid inferences for each experimental condition and personality factor.

RESULTS

As can be seen in Table 2, Modus Ponens was more common than Modus Tollens in both experimental problems ($t(93)= 14,178$; $p<0.0001$; in accordance with the hypothesis, all the statistics were calculated one-tailed) and control problems ($t(93)= 5,669$; $p<0.0001$). These results confirm those normally found in conditional inference tasks, thus validating the use of our materials for this type of study, and the idea that participants were indeed reasoning. In contrast to our predictions, Modus Tollens was more common in the control problems. This result may be due to the bi-conditional interpretation of the content we used as control (i.e., that people interpret the statement “if it

Table 1
Examples of the formulation of each type of problem

- | |
|--|
| a) Formulation in Modus Ponens
Suppose that the following statement is true in its case:
- If I’m under severe stress I feel I’m going to break down.
Now suppose that in a certain situation you are under severe stress.
What can you deduce from that situation?
.....
<input type="checkbox"/> there is not enough information to know |
| b) Formulation in Modus Tollens
Suppose that the following statement is true in its case:
- If I’m under severe stress I feel I’m going to break down.
Now suppose that in a certain situation you are not going to break down.
What can you deduce from that situation?
.....
<input type="checkbox"/> there is not enough information to know |
| c) Unfavourable problem or problem negatively associated with the factor
Suppose that the following statement is true in its case:
- If I’m in emergency situations I keep a cool head.
Now suppose that at a certain point you are in an emergency situation.
What can you deduce from that situation?
.....
<input type="checkbox"/> there is not enough information to know |
| d) Believable control problem
Suppose that the following statement is true in its case:
- if it rains I usually use an umbrella
Now suppose that in a certain situation it is raining.
What can you deduce from that situation?
.....
<input type="checkbox"/> there is not enough information to know |
| e) Unbelievable control problem:
- If it hails I use open-toed shoes
Now suppose that in a certain situation you use closed shoes.
What can you deduce from that situation?
.....
<input type="checkbox"/> there is not enough information to know |

rains I usually use an umbrella” in a symmetrical way, also implying that “if I use an umbrella it usually rains”). In fact, there is evidence that the bi-conditional increases the percentage of MT with respect to the simple conditional (Johnson-Laird & Byrne, 2002; Espino, Santamaría, & Byrne, 2009), and moreover, our control problems appear to express natural causality more clearly than the problems with personal content employed for the experimental tasks.

Table 2 also shows the data corresponding to the general hypothesis of the work with respect to the experimental problems (those related to the personality factors). As it can be appreciated, all the MP inferences were made correctly by around 100% of the participants, so that in those problems there is a ceiling effect that precludes additional comparisons. In the MT inference we can observe a general tendency that concurs with our hypothesis, in the sense that the participants made more valid inferences (51%) with the personality factor materials in which they had scored high than in those in which they had scored low (44%). However, this tendency only attained significance in the case of the positive problems, that is, those in which the item used correlated positively with the personality factor ($t(93)=1.683$; $p<0.05$). The global effect may be obscured by the differences between the items of different traits. On comparing within the same respondent the items of factors in which they scored high or low, we are comparing quite different material. Moreover, the same item that for one respondent was high, for another was low, and this undoubtedly radically reduces the likelihood of obtaining differences. That is, in the comparison made, the same item appears for different participants in different conditions, whilst different items are considered as being of the same condition.

Consequently, we carried out a between-subjects comparison in which we compared those participants with extreme high scores and those with extreme low scores in the same trait. These results are shown in Table 3. That is, we compared the same items in participants who scored high or low in the trait corresponding to

those items. For MP, as expected, scarcely any differences were found, since it is a very straightforward inference. We shall concentrate on the analysis of MT. The results confirm our predictions for the Extraversion factor, since those who scored high in this factor were better at making inferences related to it (57% of valid inferences) than those who scored low in the same factor (28%). These differences were globally significant ($t(36)=2.116$; $p<0.03$). However, in the specific comparisons (for positive and negative problems separately), only in the positive problems was statistical significance maintained ($t(36)=2.480$; $p<0.01$). In the Neuroticism factor the differences appeared in the same direction (50% of valid inferences in the high group versus 30% in the low), though they only attained a marginal level of significance ($t(39)=1.538$; $p<0.07$). In this case it was for the negative, and not for the positive problems that the marginally significant trend was maintained ($t(39)=1.588$; $p<0.06$). The remaining personality factors yielded no differences, except for Agreeableness, for which the differences were in the opposite direction to that of the hypothesis. That is, participants scoring low on this trait made more MT inferences with the trait-related material (45% valid inferences versus 19%; $t(36)=2.220$; $p<0.02$). The differences also reached significance in the case of the negative problems with respect to the trait ($t(36)=2.406$; $p<0.02$), but not in the case of the positive problems.

Our hypothesis made predictions about differences in reasoning for specific content, so that, in accordance with it, we did not expect any difference in the control problems. Indeed, no differences appeared in Extraversion, Neuroticism and Openness to experience, but they were found in Agreeableness and Conscientiousness. For the Agreeableness factor, participants who scored low made more MT inferences in the control problems ($t(92)=2.517$; $p<0.007$), whilst in the case of Conscientiousness the differences appeared in the opposite direction, insofar as more MT inferences were made in the control problems by those scoring high in this trait than those scoring low ($t(92)=2.003$; $p<0.006$). It may be, as we discuss below, that in the case of Agreeableness this finding provides the explanation for the adverse result previously described.

DISCUSSION AND CONCLUSIONS

This research is framed within a certain conception of human reasoning. If this were a question to be approached as one would approach a logical proof, in line with the suggestions of some theories (e.g., Rips,

Table 2

Percentages of valid inferences for each experimental condition

	Modus Ponens		Modus Tollens	
	Positive	Negative	Positive	Negative
High score	96	93	47	55
Low score	95	96	36	53
Control	98	96	73	79

1994) it would not make much sense to consider that personality might be involved in the reasoning process. These types of theory argue that reasoning consists in the application of formal rules independent of the content. It is not that they rule out the influence of the context or content on reasoning outcomes, but in these theories such influences could intervene before or after the reasoning process itself, which would be of a formal nature. However, if reasoning is a semantic process based on the generation of possibilities, then we can indeed consider that the fact of people contemplating one possibility or another might depend on personal aspects, so that we should predict individual differences.

In this article we have defended the semantic proposal of reasoning as put forward by Mental Model Theory on incorporating in the explanation of inferential processes elements such as the identification and selection of relevant aspects in the person's problems, knowledge, experience and practice, which appear to determine the individual features. We present a rather general and somewhat ambitious proposal about the influence of personality on human reasoning. The idea is that an individual's nature will have inferential consequences. For example, highly extravert people, having devoted a good deal of time to thinking about social situations, will have a tendency to consider a greater number of possibilities on reflecting about such situations; likewise, highly conscientious people will have accumulated experience in thinking about situations in which order and organization are relevant. All of this will tend to make people expert reasoners in certain areas. This hypothesis was partially confirmed in the present work. We have seen, indeed, that people tended to make more valid inferences of the MT type when they reasoned with materials taken from the items corresponding to the personality factors in which they scored high.

Our hypothesis differs clearly from approaches that defend a mere effect of the credibility of premises on reasoning. It is obvious, quite apart from the empirical evidence available for it, that people will find it easier to accept believable conclusions than unbelievable ones (see, for example, Santamaría, García Madruga and Johnson-Laird, 1998). In accordance with this principle, the fact that a person accepts as valid a conclusion that concurs with their personality type could be explained simply because it is believable to them. However, the idea that our personality makes us experts in certain areas of reasoning is applied to both believable and unbelievable propositions. That is it would be the field

in which reasoning takes place, and not the valence of the conclusion, that would define expert reasoners according to their personality. For this reason we used problems with both positive and negative content in each personality factor, and hypothesized effects in both directions. Nevertheless, we did always find them in this work. In general terms, the hypothesis was confirmed with a standard level of significance only for the positive content. Although in some cases we also found the effects with negative content, it could be argued that our principal results are explained by mere credibility. Even so, we need to consider the structure of the MT inference to realize that such an explanation is not satisfactory. We could say that the conditional rules used in the problems with positive content are believable for those participants scoring high in the corresponding factor. For example, the statement "If I'm under severe stress I feel I'm going to break down" could be credible for a person with high Neuroticism, but the MT structure involves the addition of a categorical premise that says "Now suppose that in a certain situation you are not going to break down." The correct resolution of the problem depends precisely on respondents taking into account situations in which they are under stress and others in which they are not, so that the explanation of their better reasoning depends more on the number of possibilities they are capable of considering than on the believability of the conclusion. The effect of credibility on reasoning tends to give rise to an interaction whereby problems with credible conclusions are less influenced

Table 3
Percentages of valid inference for each experimental condition and personality factor

	Modus Ponens		Modus Tollens		N
	Positive	Negative	Positive	Negative	
Neuroticism					
High score	94	78	50	50	18
Low score	96	91	35	26	23
Extraversion					
High score	100	95	64	50	22
Low score	87	87	25	31	16
Openness to experience					
High score	100	100	71	71	14
Low score	100	100	59	88	17
Agreeableness					
High score	83	89	11	28	18
Low score	90	100	25	65	20
Conscientiousness					
High score	100	100	41	77	22
Low score	100	100	41	65	17

by their logical structure than those with unbelievable conclusions. It would seem that we feel forced to think about other possibilities or counter-examples when the initial conclusion is less than plausible. In our data it cannot be verified whether this interaction occurs for problems related to personality as well as for those not related to personality. Other logical structures would have to be used to obtain such verification. But our prediction is clear, and was partially supported in this study: together with the interaction between credibility and logical structure there is another between that structure and personality. In difficult or logically complex problems (to some extent in our MT), people with extreme scores in the related personality factor will consider more possibilities and resolve them better; in problems resolved with a single possibility (such as MP) we do not predict such clear differences.

On analyzing specific personality traits we obtained only partially satisfactory results for our hypothesis. Indeed, the results only attained significance for the Extraversion trait, being marginally significant for Neuroticism. A possible explanation of these results can be found in the fact that these factors have traditionally been referred to as *basic factors*. Thus, they have been considered more stable and have a more well-documented biological basis, they have been the object of more research, and therefore they are more likely to have been described in depth and to be better defined in the instruments currently used. For these factors the percentage of Modus Tollens was higher in the group of participants with high scores. It is interesting to note that the high Neuroticism trait (*per se*, or for its similarity to trait anxiety) has traditionally been associated with difficulties for resolving various types of task. Here, on the other hand, we found that the more neurotic respondents reason better with certain content than the more stable ones.

The most adverse result, in principle, of those obtained in this study concerns the fact that participants scoring high in Agreeableness reasoned significantly more poorly than those who scored low in the problems that had been constructed with the items of this factor. It may be that this result is the consequence of the between-subjects comparison in which it appears. To explain it, it is useful to recall that in the control problems the participants scoring high in Agreeableness also turned out to be poorer at making the MT inference than those scoring low in this factor. This result concurs with some previous findings in the field of relations between general intelligence and personality (Bakera & Bichsel,

2006). In fact, according to our results, those with high levels of Agreeableness differ from those scoring low precisely due to their especially low percentage of valid MT inferences (less than 20%).

In this work we used the items of the questionnaire most widely employed in the field of personality today. There are other forms of approaching research in this context which would involve the use of other types of material, and also the exploration of other aspects of the personality area potentially related to reasoning capacity, such as "Need for cognition" or "Tolerance for uncertainty or Tolerance for ambiguity" (Carver, 2006; Evans, 2008; Felces, Brinol, Sierra-Díez, Becerra, & Alier, 2001). It may be time to consider a more complex relationship between personality and abilities. Various personality factors may facilitate activity in certain domains and impede them in others.

For the time being, our results suggest that the most relevant personality factors (Extraversion and Neuroticism) give rise to a more satisfactory form of reasoning about topics related to one's personality profile. This result is in line with the notion that personality might influence the way people reason, providing further evidence to add to that we already obtained for other factors (Fumero, Santamaría, & Johnson-Laird, in press). This finding is readily explainable from the perspective of Mental Model Theory, in which reasoning depends to a large extent on one's ability to generate possibilities about diverse states of the world. People would be capable of doing this more thoroughly when the content of the problems is more in keeping with their personality profile.

ACKNOWLEDGEMENTS

This work was funded by project SEJ2006-14714 from the *Plan Nacional de I+D del MEC* (Spanish Ministry of Education and Science), by project 1802390701 from the University of La Laguna and by National Science Foundation Grant SES 0844851 awarded to the third author.

REFERENCES

- Bakera, T.J., & Bichsel, J. (2006). Personality predictors of intelligence: Differences between young and cognitively healthy older adults. *Personality and Individual Differences*, *41*, 861-871.
- Beck, A.T. (1976). *Cognitive therapy and the emotional disorders*. New York: International Universities Press.
- Braine, M.D.S., & O'Brien, D.P. (1991). A theory of if:

- A lexical entry, reasoning program, and pragmatic principles. *Psychological Review*, 98, 182-203.
- Carver, R. (2006). *Ambiguity Intolerance: An Impediment to Inferential Reasoning?* Paper presented at the Joint Statistical Meetings, Seattle, WA.
- Costa, P.T., & McCrae R.R. (1999). *Inventario de personalidad NEO revisado (NEO-PI-R) e inventario NEO reducido de cinco factores (NEO FFI). Manual profesional*. Madrid: TEA Ediciones.
- Espino, O., Santamaría, C., & Byrne, R (2009). People think about what is true for conditionals, not what is false: Only true possibilities prime the comprehension of 'if'. *Quarterly Journal of Experimental Psychology*, 20, 1-7.
- Evans, J. B. T. (2008). Dual-Processing Accounts of Reasoning, Judgment, and Social Cognition. *Annual Review of Psychology*, 59, 255-278.
- Felces, C., Brinol, P., Sierra Díez, B., Becerra, A., & Alier, E. (2001). Validación de la escala de necesidad de cognición y su aplicación al estudio del cambio de actitudes. *Psicothema*, 13, 622-628
- Fumero, A., Santamaría, C. & Johnson-Laird, P.N (2010). Reasoning and autobiographical memory for personality. *Experimental Psychology*, 57(1), 215-220.
- García Madruga, J. A, Gutiérrez, F, Carriedo, N., Vila, J. O., & Luzón J.M. (2007). Mental models in propositional reasoning and working memory's central executive. *Thinking and Reasoning*, 13(4), 370-393.
- Inhelder, B., & Piaget, J. (1955). *De la logique de l'enfant a la logique de l'adolescent*. Paris: P.U.F.
- Harman, G. (1986). *Change in View: Principles of Reasoning*. Harvard, Mass: MIT Press.
- Johnson-Laird, P.N., & Byrne, R.M.J. (2002). Conditionals: a theory of meaning, pragmatics, and inference. *Psychological Review*. 109, 646-678
- Johnson-Laird, P.N. (2006). *How We Reason*. Oxford: Oxford University Press.
- Johnson-Laird, P., Mancini, F., & Gangemi, A. (2006). A hyper-emotion theory of psychological illnesses. *Psychological Review*, 113, 822-841.
- McCrae, R.R., & Terracciano, A. (2005). Universal Features of Personality Traits From the Observer's Perspective: Data From 50 Cultures. *Journal of Personality and Social Psychology*, 88(3), 547-561.
- Rips, L. (1994). *The Psychology of Proof*. Cambridge, MA: MIT Press.
- Santamaría, C., García Madruga, J.A., & Johnson-Laird, P.N. (1998). Reasoning from double conditionals: The effects of logical structure and believability. *Thinking and Reasoning*, 4, 97-122.