

REASONING WITH THEMATIC SELECTION TASK*

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INTRODUCTION

Peter Wason (1966, 1968) designed one of the experimental tasks most used by the cognitive psychologists to study how subjects reason: the **selection task**. The **main objective of this work** is to present some of the experimental studies on this task that there have analyzed **the role of semantic and pragmatic variables**, such as the content of the rule, the context, the empirical knowledge or the experience of the subjects. In addition, the principal theoretical explanations on the task will be described: The Theory of Pragmatic Reasoning Schemas, the Social Contract Theory, the Heuristic-Analytic and the Double Process Theories and the **Mental Models Theory** (Johnson-Laird, 1983; Johnson-Laird & Byrne, 1991; 2002). We focus on the last one, that is the main framework in which **professor García Madruga** developed his research on reasoning during decades. He is a key reference for the authors from the eighties and it is a pleasure for us to have this opportunity of honouring him.

THE SELECTION TASK: SOME EMPIRICAL RESEARCH

This task involves presenting the subjects with four cards which have a number (odd or even) written on one side and a letter (vowel or consonant) on the other side. Immediately afterwards, a conditional rule is presented: **“If a card has a vowel on one side then it has an even number on the other side”**. Subjects were shown four cards which had on their exposed sides: a vowel, a consonant, an even number and an odd number. They had to select **wich cards to turn over in order to decide whether the rule is true or false**. Less than 10% of subjects answered correctly: **“E” and “7”**. Furthermore, they systematically committed different mistakes: they either selected the card “E” (*verification bias*: Wason, 1968) or they selected “E” and “4” cards (*matching bias*: Evans, 1972, 1998). **Why intelligent adults fail to solve it?**. In order to answer this question, other versions were designed. A selection of empirical research on the thematic task is presented in table 1.

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Table 1. Some empirical research on semantic and pragmatic factors in the selection task, in chronological order.

Authors	Rule-Example	Result-Explanation
Wason & Shapiro (1971)	<i>“Every time I go to Manchester I travel by car”</i>	Facilitation of thematic content.
Johnson-Laird, Legrenzi & Legrenzi (1972)	<i>“If a letter is sealed , then it has a 50 lira stamp on it”</i>	Facilitation of thematic content.
Manktelow & Evans (1979)	<i>“If I eat a haddck, then I drink gin”</i>	No thematic facilitation in arbitrary relationship.
Griggs & Cox (1982)	<i>“If a person is drinking beer, then the person must over 19 years of age”</i>	Facilitation by content-experience relationship.
Manktelow & Over (1991)	<i>“If you tidy up your room, then you may go out to play”</i>	Selection of cards wich breaks the rule: Child: “p & not-q”. Mother: “not-p & q”.
Asensio, Martín Cordero, García Madruga & Recio (1991)	<i>“If a person is driving a car, then he must be over 18 years old”</i>	Execution by double syntactic-semantic processing.
Valiña, Seoane, Ferraces & Martín (1995)	<i>“If a person is sitting in the front seat of a car, then that person must be over 12 years of age”</i>	Better performance in thematic version. Facilitation of violation instructions. Individual differences.
Valiña, Seoane, Ferraces & Martín (1998)	<i>“If a person is riding a motorbyke then he must wear a helmet”</i>	Interactive effect instructions and content. Superior logical indexes in deontic versions.
Stanovich & West (1998)	<i>“If Baltimore is on one side of the ticket then plane is on the other side of the ticket”</i>	Better performance in deontic version. Individual differences.
Martín, Valiña & Evans (1999)	<i>“If a card has a bricklayer written on one side, then it must have/has hard hat written on the other side”</i>	Effect of scenario in deontic problems. Better performance in permission or obligation rules.
Valiña, Seoane, Ferraces & Martín (2000)	<i>“If a person is more than 18 years old, then he has the right to vote”</i>	Facilitation of violation instructions. Better performance in the thematic-obligation task. Individual differences.
Almor & Sloman (2000)	<i>“If an employee gets a day off during the week, then that employee must have worked on the weekend”</i>	Looks for a rule-history coherence.
Giroto, Kemmelmeier, Sperber & van der Henst (2001)	<i>“If a person travels to any East African country, then that person must be immunized against cholera”</i>	The context expressed in the text modulates the relevance to make inferences.

Table 1 (continued). Some empirical research on semantic and pragmatic factors in the selection task, in chronological order.

Handley, Feeney & Harper (2002)	<i>"If a customer lives in Tavistock then they pay the reduce tariff". "If a customer lives ... Plymouth/Totnes then they pay the reduced tariff"</i>	Selection of cards influenced by the presence of a second rule.
Ayal & Klar (2014)	<i>"If you buy my miracle medicine for \$ 12.50, you will be cured in less than ten days". "If you give me \$ 60, then I will have the furniture delivered and assembled in your home"</i>	Different cheating ploys modulate the selection. Key: necessity/sufficiency of the cost-benefit relationship.
Thompson, Plowright, Attance & Caza (2015)	<i>"If it is the first day of the month, then there must be pancakes for lunch" "If the child takes a cookie then the child must have earned a gold star sticker"</i>	Interaction type of problem ("cheater or non-cheater") and parental connection with the child (existent or non-existent.)
Fiddick, Brase, Cosmides & Tooby (2017)	<i>"If you go out at night, then you must first milk the cow". "If a man eats cassava root, then he must have a tattoo on his face"</i>	Structural priming. Reasoning is based on specific evolved reasoning abilities.

The role of thematic factors is one of the key questions analyzed in the empirical research. To theoretical level, how the influence of these variables in reasoning with the selection task has been explained?

THE SELECTION TASK: THEORETICAL EXPLANATIONS

The Theory of Pragmatic Schemas (Cheng and Holyoak, 1985; 1989) and the Theory of Social Contract (Cosmides, 1985; 1989) have explained the content effect in the selection task. The first one suggested that some versions of the task can trigger special rules learned from the life experiences: pragmatic schemas, which express permissions or obligations. For example: "If a precondition is not satisfied then the action must not be taken". From the Theory of Social Contract, the subjects activates social contract rules, such as "If you take a benefit, then you pay a cost" and a procedure for checking cheaters, that is evolved as a result of natural selection.

The Heuristic-Analytic Theory (Evans, 1984; 1989) proposes two general phases in the reasoning: the phase of heuristic processing, based on selecting the relevant information and the analytical phase of explicit reasoning. The execution can be modulated in both phases (Evans, 2006), for linguistic, semantic and / or pragmatic variables. These factors will determine what cards are the relevant ones to be selected like correct. Linked with this approach, the Theory of Double Process (Evans and Over, 1996; Evans and Stanovich, 2013), proposes the existence of two systems: the system 1 or implicit, that facilitates the automatic activation of the empirical knowledge to reason and the system 2 or explicit, that is the base of the hypothetical thinking (Evans, 2019).

The Theory that has proposed the elaboration of semantic representations to reason is the Theory of Mental Models (Johnson-Laird, 1983; Johnson-Laird and Byrne, 1991; 2002). The subjects reason elaborating mental models from the meaning of the premises and the general knowledge. They represent only true models (principle of true). The conclusion provided is valid if there is no a counterexample (that is a possibility in which the premises hold but the conclusion does not hold). Due to the working memory limitation, subjects consider only those cards explicitly represented in their initial models of the rule. If it is not possible to elaborate the conclusion from this representation, then they flesh out other alternative models. Specifically, in the rule presented in Wason’s original version: “If a card have a vowel on one side, then it have an even number on the other side” subjects tend to construct the following mental models and to base their selections on them:

vowel even
 . . .

The model theory allows to explain both the correct answer and the most frequent mistakes. For example, reasoners can commit the matching bias because they attend to those elements that they have explicitly represented in the initial model. Any manipulation that makes explicit what is false, can lead subjects to flesh out the three explicit models of the conditional and should enhance performance in the selection task:

vowel even
 \neg vowel even
 \neg vowel \neg even

The Theory of Mental Models has explained the role of thematic factors from the mechanisms of semantic-pragmatic modulation (Johnson-Laird and Byrne, 2002). The content of the rule, the context and the general knowledge can block or activate the construction of alternative models, controls the subjects’s selections and definitively, modulate their reasoning.

CONCLUSIONS

Different variables have been proposed in order to explain the reasoning with the four card problem. An important part of empirical researches on the task seem to emphasize the plasticity of the reasoning towards factors related to the content, the context and the empirical knowledge (Valiña & Martín, 2016). To theoretical level, some of the main approaches that have explained the reasoning with this task are: the Theory of Pragmatic Schemas, the Social Contract Theory, the Theory of Heuristic-Analytic and the Double Process Theory and the Theory of Mental Models. The experimental research with this metainference task constitutes the base of general theoretical debates as the analysis of the most suitable methods to study the reasoning, the human rationality or the study of the individual differences (Chater et al., 2018; Seoane, Valiña, Rodríguez, Martín & Ferraces, 2007; Stanovich & West, 1998; Stanovich, West & Toplak, 2016; Valiña, Seoane, Ferraces & Martín, 1995; 2000).

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