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REASONING ON DEONTIC RULES: THE PRAGMATIC SCHEMAS APPROACH

This paper is not concerned with the role of *linguistic pragmatics* laws on reasoning, but with the relation between *pragmatic knowledge* (i.e. knowledge of the content of arguments) and reasoning. After a brief review of some empirical findings of content effects in the area of conditional reasoning, the complex pattern of content effects observed on a meta-inferential task (Wason's selection task) will be considered. A recent approach which deals with the specific performances obtained when this task concerns social rules (particularly deontic ones), will be introduced and subsequently compared to some alternative approaches.

1. The problem of content effects on reasoning

1.1. Conditional reasoning

Since the beginning of the psychological literature on reasoning (e.g. Wilkins, 1928), the problem of how knowledge of subject matter or content of a set of premises can affect the inferential processes of drawing a conclusion, has been considered as an essential issue in the field.

Several studies have shown that the interpretation of the link between the antecedent (*p*) and the consequent (*q*) of a conditional statement *if p*

then q depends on *what* these components mean. For example, it has been shown that subjects' evaluation of the conclusion of conditional syllogisms depends on the relationship between the antecedent and the consequent of the conditional premise. In these tasks, subjects are required to evaluate the logical validity of arguments consisting of two premises (a conditional statement *if p then q,* and its antecedent or its consequent, in affirmative or negative form, i.e. *p*, *not-p*, *q* and *not-q*) and a conclusion (i.e. the antecedent of the conditional statement, negated or unnegated, when the second premise is the consequent; the consequent of the conditional premises, negated or unnegated, when the second premise is the antecedent).

Using this paradigm, Marcus and Rips (1979) found fewer cases of acceptance of the two fallacious schemas (i.e. Denial of the Antecedent: *if p then q, not-p,* therefore *not-q* ; and Affirmation of the Consequent: *if p then q, q,* therefore *p*) with an arbitrary rule ('*If the fish is red, then it is striped')* than with a causal rule ('*If the ball rolls left, then the red light flashes')*. Roberge (1982) found fewer cases of fallacious affirmation of the consequent with a class inclusion rule ('*If there is a trout, then there is a fish')* than with a causal-temporal rule (*'If the alarm clock rings, then I wake up*'). (Agnoli, 1978, obtained similar results using quantified syllogisms).

Similar results have also been reported by other investigators, using tasks in which the subjects were requested to produce the *conclusion* which followed from a conditional statement, supposed to be true, and another premise (*p* is true, *p* is false, *q* is true, *q* is false). For example, Markovits and Lesage (1990) showed that conditional promises (e.g. '*If Lise cleans up her room, she will go to the movies*') elicited more biconditional interpretations (i.e. '*If and only if Lise cleans up her room, she will go to the movies')* than arbitrary rules (e.g. '*If a fish is red, it has wings*').

These content effects on the interpretation of conditional statements are consistent with the evidence from a variety of tasks on conditional reasoning.

The 'truth table evaluation task' consists of deciding the truth value of a conditional statement when *p* and *q* are true, *p* is true and *q* is false, etc. Results obtained with this type of task indicate marked differences between abstract and meaningful sentences (Leahey, 1977), and between different kinds of meaningful sentences. Marcus and Rips (1979) observed a biconditional interpretation when the statement suggested a causal mechanism ('*If the ball rolls left, then the red light flashes')* but not when the statement referred to arbitrary associations ('*If the fish is red, then it is striped*' or '*If there' s a B on the left side, then there' s a 1 on the right side)*. Similar results have also been obtained, among others, by Johnson-Laird and Tagart (1969), Legrenzi (1970) and Politzer (1981).

All these results concur to show that in a conditional reasoning task subjects are responding, not just to the the conditional form of the statement, but also to the subject matter of the task. In particular, these results show that the conditional formulation of deterministic causal relations or promises gives rise more often to a biconditional interpretation than arbitrary, class-inclusion or necessity relations, and that these different interpretations contribute to determining people's reasoning.

1.2. The selection task

The analysis of the different content effects has been utilized as a case against logical formalisms employed as theories of thought (e.g. Johnson-Laird, 1983), and also as a tool for discriminating between different non-formalistic theories of reasoning (e.g. Cheng and Holyoak, 1985, 1989; Cosmides, 1989). This debate has become particularly lively in the area of meta-inferential reasoning (i.e. that measured in tasks in which subjects

are not simply requested to draw inferences, rather to make inferences about the conditions which would allow valid inferences). This area is dominated by research on a theoretically relevant problem: the Wason selection task (1966).

Several studies using this task showed that the majority of adult subjects did not search for counterexamples to a conditional rule of the form '*If p then q*', such as: "*If a card has a vowel on one side, then it has an even number on the other side*". In a typical version, subjects are presented with an array of four cards showing, for example A, D, 2 and 5. They are told that each card has a letter on one side and a number on the other side. The problem is to select only those cards that need to be turned over in order to determine whether the rule is true or false. The correct solution is to choose the A (*p)* and the 5 (*not-q*) cards, the only choices which could lead to discover the potential counterexamples (i.e. the combination 'vowel and odd number' on the same card). Most subjects select the A and the 2 (*q*) cards, failing to select one of the potentially falsifying cards, i.e. the 5 card.

The failure 'to reason about a proposition considered as a hypothesis independently of the truth of its content' (Beth and Piaget, 1966) was initially emphasized as a case against Piagetian theory, the most famous logic-based explanation of thinking (Wason and Johnson-Laird, 1972). [1] Subsequent research has shown that varying the content of the problem and putting it in a different context, can abolish the prevalence of error. A

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[1] An analysis of erroneous performance on the selection task simply in terms of *confirmation bias* (or verification principle, cf. Wason, 1966) cannot explain the correct performance obtained with versions of the task in which the tested rule presented a negative consequent (e.g. "*If there is an A on one side of the card, then there is not a 2 on the other side of the card"*). This and related phenomena (cf. Evans, 1989, for a review) have been explained in terms of a *matching bias*, that is, the subjects' tendency to match their responses to the stimuli named in the test-sentence. Selection performance with abstract rules seem, therefore, determined more by linguistic factors, which direct attention to only a selected number of logical cases, than by a general inability to falsify the hypothesis (cf. 2.2).

pivotal study was done by Johnson-Laird, Legrenzi and Legrenzi (1972). Subjects were asked to imagine they were postal workers sorting the mail. They had to track letters — real envelopes were used as the 'cards' — which violate the following postal regulation: "*If a letter is sealed, then it has a 50 lire stamp on it*". Just under 90% of people selected the correct envelopes: the sealed one (*p)* and the one without a 50 lire stamp (*not-q*). This effect was the same with Italian or British units of currency (the subjects were British), and it was interpreted in terms of the activation of a falsification strategy due to the realistic, thematic content.

But actually the content effects themselves proved rather elusive in subsequent research (cf. reviews by Griggs, 1983; Pollard, 1982; Wason, 1983). In fact, realistic contents did not guarantee facilitation. For example, the facilitation obtained with the postal rule was not replicated with American subjects who had never experienced this type of rule (Griggs and Cox, 1982), or with British subjects who were too young to remember the now-defunct British postal regulation (Golding, 1981). For this reason, an explanation of observed facilitation with thematic material was proposed in terms of subjects' *direct experience* with such material, i.e. in terms of memory cueing of prominent counterexamples to the rules to be tested, as a function of the subjects' experience. Griggs and Cox (1982) provided some confirmation of this hypothesis by obtaining a very high success rate in a version of the problem based on a rule which was highly familiar to their subjects — the Florida drinking law: "*If a person is drinking beer then the person must be over 19*.." Facilitation obtained with rules for which subjects were highly unlikely to have available counterexamples in memory (e.g. D'Andrade, described in Rumelhart, 1980), or with rules not consistent with the real world (Griggs and Cox, 1983), were explained as a result of a transfer process. Real-world experiences with rules *similar* to that of the problem, and with counterexamples to those rules, were supposedly cued in by problem content and then used along with a reasoning-by-analogy process to solve

the task (Griggs, 1983). In this way, the possibility was considered that improved performance is not just a function of memory-cueing of the real-world counterexamples. However, the failure to elicit correct performance with rules for which subjects *were* likely to have experienced counterexamples (e.g. '*If I eat haddock, then I drink gin*', Manktelow and Evans, 1979), suggested that the more general memory-cueing/reasoning-by-analogy hypothesis was not a satisfactory explanation of correct performance on selection tasks.

2. The specificity of deontic domain

Recently, two similar, although competing, explanations of content effect on reasoning have been proposed: the pragmatic reasoning schemas theory (Cheng and Holyoak, 1985, 1989; see also Cheng, Holyoak, Nisbett and Oliver, 1986), and the social contract theory (Cosmides, 1989; see also Cosmides and Tooby, 1989). Despite differences, both approaches attempt to define the nature of the knowledge which leads to the content effects on reasoning, and argue that a specific role in determining these effects is played by the knowledge concerning the *deontic domain* (that is, knowledge about social regulations such as permission and obligation).

In this section, the two approaches will be discussed in some detail. Afterwards, I shall compare them both from a theoretical and an empirical point of view.

2.1. The pragmatic reasoning schemas approach

Cheng and Holyoak (1985, 1989) have proposed the pragmatic schemas approach to reasoning within a general approach to the study of inferences, which is characterized by a specific consideration of the *context* and *goals* of the cognitive system (Holland, Holyoak, Nisbett and Thagard, 1986).

According to Cheng and Holyoak, people often reason using neither formal syntactic rules of inference, nor memories of specific experiences, but rather pragmatic reasoning schemas, such as "permissions", "obligations" and "causations". These knowledge structures are abstracted clusters of rules, which are potentially applicable to different content domains, but nonetheless are constrained by particular classes of 'pragmatically important goals and relationships to these goals' [2]. Under certain circumstances, some of these schemas, particularly those related to deontic matter, lead to the correct solution of reasoning problems, in a way that appears consistent with standard logic.

Before giving an illustration of the way in which some deontic schemas facilitate reasoning performance, it is worth noting that pragmatic reasoning schemas are not confined to the realm of deontic regulations. Outside this field, Cheng and Holyoak claim that people use pragmatic schemas in reasoning about realistic problems concerning covariation, correlation and causality (cf. Cheng *et al*., 1986). In the domain of causality, pragmatic schemas are cognate to the 'causal schemata' of Kelley's (1973) model, in which it is assumed that people make causal attributions (i.e. explain others' behaviour) on the basis of limited information. These attributions can be made because people have theories or preconceptions ('schemata') about what causes are associated with what effects (cf. Cheng and Novick, 1990).

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[2] From a general point of view, pragmatic schemas are content-specific rules of inference which represent real world knowledge in a procedural form.

Among deontic schemas, the permission ('*If one wants to do action A, then one must satisfy precondition B*') and the obligation ('*If condition A occurs, then action B must be fulfilled*') ones have production rules which correspond to the logic of implication. For example, a permission schema has a rule which corresponds to the contrapositive inference ('*If precondition B is not satisfied, then action A must not be taken*'; formally: *if not-q then not-p*), and rules which block the classical fallacies of Denying the Antecedent and Affirming the Consequent (respectively '*If action A is not to be taken, then it is irrelevant whether or not precondition B is satisfied*', and '*If precondition B is satisfied, then action A can be taken*'). Given this correspondence, the activation of one of these schemas should produce correct performance in tasks that require inferences following from the material conditional, like in the selection task.

This prediction, supported by the fact that previous facilitations were obtained in versions in which the rules tested were actually permissions, was further corroborated by Cheng and Holyoak's (1985) own experiments.

In one case, they showed that subjects without experience on a specific permission rule but with a rationale enabling them to understand it, produced the same performance as "expert" subjects. For example, US college students, lacking direct experience with the described postal rule used by Johnson-Laird *et al.* (1972), reached the same performance as students in Hong Kong (who had experience with a similar postal rule in real life), provided that an explicit rationale for understanding the rule was given (i.e. 'sealed letters are personal and must therefore carry more postage than unsealed letters').

Furthermore, Cheng and Holyoak (1985, expt. 2) showed that even the purely abstract description of a permission situation (i.e. with no reference to any concrete content) elicited a high rate of correct selection performance. For example, a version of the task in which subjects have to

test a rule like '*If one is to take action A, then one must first satisfy precondition B*' (with four cards showing '*Has taken action A*', '*Has not taken action A*', '*Has satisfied precondition B*' and '*Has not satisfied precondition B*'), produced significant facilitation relative to the standard version concerning concrete but arbitrary relationships between letters and numbers.

The empirical evidence that people are able to search for counterexamples of unfamiliar or abstract regulative rules seems difficult to be explained by alternative approaches. In particular, an explanation in terms of familiarity or in terms of availability of the counterexamples, according to which correct selection performance is based upon the ease with which the potential counterexamples are brought to mind (cf. Griggs, 1983; Pollard, 1982), cannot easily account for the data. Taken together, these results seem to corroborate the hypothesis that people can reason by using abstracted clusters of rules such as permission and obligation schemas.

2.2. The problem of the abstract representation of schemas

The demonstration by Cheng and Holyoak (1985, expt. 2; see also Cheng and Holyoak, 1989) of the facilitatory effect produced by an abstract version of a permission rule is a noteworthy finding. First of all, reliable facilitation has never been shown for any other abstract version of the selection task. Secondly, it can be considered as the most convincing demonstration of the existence of pragmatic schemas, since they are assumed to operate at a relatively general level, being cued even in absence of concrete contents. For these reasons, a recent claim that these facilitations depend upon presentation factors, and not upon the evocation of a pragmatic schema, will be described in some detail.

Jackson and Griggs (1990) noted that in abstract versions of the permission problems used by Cheng and Holyoak (1985), the *not-p* and

not-q cards presented explicit negatives ('*Has not taken action A'* and '*Has not satisfied precondition B'*, respectively). Now, Evans (1983) has shown that the use of explicit negatives can facilitate the performance in the conditional truth-table evaluation task. For example, given the conditional rule '*If the letter is not A, then the number is 7*' and the combination '*The letter is B and the number is 4*', subjects should logically evaluate this combination as false, since it represents a counterexample (*p and not-q*) to the rule (*if p then q*). Faced with this task, some of the subjects tend to consider the combination as irrelevant, presumably because the values on the combination and those in the conditional rules do not match ('matching bias effect', cf. note 1). However, Evans (1983) reduced this tendency by presenting combinations with explicit negatives (for example, '*The letter is A and the number is not 7*'). In this case, given that there is no mismatching between the values (ignoring negatives) of the combination (*A and 7*) and those of the rule (*A and 7*), the combination is not considered as irrelevant, but, correctly, as a counterexample to the rule.

On the basis of these results, Jackson and Griggs (1990) hypothesized that the presence of explicit negatives in the cards used in the abstract schema versions of the selection problems could be the critical factor responsible for the obtained facilitation. In one experiment [3], they showed that the facilitatory effect of permission and obligation schemas disappeared by removing the explicit negatives from the *not-p* and *not-q* cards (which, respectively, showed '*Has taken action B*' and '*Has fulfilled*

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[3] In a further experiment Jackson and Griggs (1989, expt. 4) showed that the inclusion of a 'checking context' (in which subjects are invited to play the role of an authority checking whether or not people are obeying certain regulations) is necessary for the facilitative effect on abstract schemas. However, since the absence of such a context does not permit to identify the abstract rule ('*If one is to take action A, then one must first satisfy precondition P* ') as a regulative one (i.e. it can also fit a non-social 'descriptive' or ‘instructive’ rule such as 'If one is to start apparatus A, then one must first press push-button P'), this finding cannot be considered as a demonstration of the necessity of a checking context for producing facilitation in an abstract *permission* problem.

precondition R', in relation to the rule '*If one is to take action P, then one must first satisfy precondition Q*'). In this condition, the percentage of correct performance was as poor as in the standard version of the task (about 10%). The authors proposed an explanation of this finding based on the hypothesis that explicit negatives on the *not-p* and *not-q* cards focus attention on them. (The other two cards, *p* and *q*, are already attended to since they are named on the tested rule, that is, they comprise its linguistic topic). Thus, on a heuristic base, *all four cards* are attended to as relevant. Subjects operate the analytic generation of inferences upon the results of this heuristic processing (cf. Evans, 1984). If the context is such that a 'look for potential violators' is activated (i.e. the rule is interpreted as a deontic regulation), subjects will operate the (logically correct) selection of *p* and *not-q* cards. (When the context does not permit to clearly interpret the rule as a deontic regulation, subjects will produce the selection of *p* and *q* cards, independently of the presence of implicit or explicit negatives). However, even in contexts where the deontic interpretation is possible, the absence of explicit negatives on *not-p* and *not-q* cards will reduce the attentional focus on them, increasing, by contrast, that on the other two cards (*p* and *q*). Consequently, as Jackson and Griggs concluded, selection performance will be "poor as it is *normally*" (emphasis added).

However, it should be noted that, contrary to the authors' claim, selection performance in these conditions, albeit poor, differed from the usual incorrect patterns. In fact, in the abstract permission schema problem with implicit negatives there were more *p*-only than *p* and *q* erroneous responses. Usually, in the traditional abstract versions, the prevalent error is the selection of *p* and *q* cards. (A high rate of *p*-only error was also obtained in the abstract permission condition with explicit negative, where it was not the prevalent response, given that in this case most of the subjects made the correct selections). Now, if performance in the abstract permission problems were due only to attentional factors,

people should have selected *all* the relevant cards. In particular, they should have selected the *q* card, as it is the case with the classical abstract problem.

It can be argued that this peculiar erroneous performance is due to an analytic judgement of pragmatic relevance, rather than to an heuristic judgement of linguistic relevance. Faced with a permission rule, albeit abstract, subjects will tend to (correctly) understand the task as a request for searching for *potential violators* of the rule. Thus, they will not select the cards that, from this point of view, they will judge as irrelevant. On the basis of this principle of pragmatic relevance (which will also determine the selection of card *p* and not that of card *not-p*), the *q* card will not be selected since, although linguistically attended to, it does not represent a potential violation ('*Has satisfied the (requested*) *precondition Q*').

Consider now the *not-q* card. When it is clear that it represents a potential violator ('*Has not satisfied precondition Q*') it will be selected. However, when contextual factors (including the linguistic form of the card) do not permit to clarify this point, it will not be selected. Thus, a *not-q* card expressed with an implicit negative ('*Has satisfied the precondition R*') will not be selected if the context does not sufficiently clarify that '*having satisfied precondition R*' implies '*not having satisfied the (requested) precondition Q*'. There are in fact at least two interpretations of the former statement in which the latter is not implied. On the one hand, *R* could be a precondition completely *remote* from the class of actions and preconditions indicated by *A* and *Q*, therefore completely irrelevant. That is, although formally *R* is complementary to *Q*, from a pragmatic point of view, *R* could be outside the class of the plausible preconditions which violate precondition *Q* (i.e. outside the real *not-Q* situations). Given this ambiguity, a *not-q* card showing precondition *R* will not be selected. On the other hand, and more likely, *R* could be a *specific subclass* of the requested precondition *Q* . In other words, *R* could be considered as equivalent to precondition *Q'* (where *Q'* is a subclass of *Q*), and evaluated

as a case in which the rule cannot have been violated. Thus, it will not be selected.

Ambiguity in understanding the pragmatic relationship between *R* and *Q*, rather then the sheer absence of the linguistically explicit negation on the *not-q* card, might be responsible for the poor (but peculiar) performance on the abstract permission problem obtained by Jackson and Griggs (1990). Since their experiments do not permit to rule out this interpretation, Alberto Mazzocco, Paolo Cherubini and I did a series of experiments in order to show that syntactically explicit negatives on the cards are not necessary for producing facilitation, provided that the context makes clear that '*having satisfied precondition R*' implies '*not having satisfied the requested precondition Q*'.

In one of these experiments (Girotto, Mazzocco and Cherubini, 1991), we presented on the cards a series of actions and a series of preconditions, rather than just one action and one precondition. The potential actions a person could have done were represented on the left side of each card. A mark indicated whether a particular action had been done or not. Similarly, the potential preconditions a person could have satisfied were represented on the right side, and a mark indicated whether a particular precondition had been satisfied or not. Only one side (the left-action side or the right-precondition side) of each card was visible. For example, given the rule '*If one is to take action C, then one must satisfiy precondition 2'*, the card showing on the left side: '*Actions this person has done: A (X), B ( ), C (X) ... N (X)*', (where the mark *X* in brackets indicates that a particular action has been done), represents the case *p* . The card showing '*Actions this person has done: A (X), B (X), C ( ) ... N (X)*', represents the case *not-p* . Similarly, the card showing on the right side: '*Preconditions this person has satisfied: 1 (X), 2 (X), 3( ) ... N (X)*', represents the case *q*, whereas the card showing '*Preconditions this person has satisfied: 1 (X), 2 ( ), 3( ) ... N (X)*' represents the *not-q* case. As it can be seen, in this last case, despite the absence of explicit negatives, the card

indicates without pragmatic ambiguities that the person in question has not satisfied the requested precondition. With this type of material we obtained a very high rate of correct *p* and *not-q* performance both with permission (71% correct) and obligation (59% correct) rules. This and other results we obtained in related experiments have corroborated our hypothesis that Jackson and Griggs' data were due to the pragmatic ambiguity of their material. More generally, they give support to the hypothesis that reasoning on deontic, albeit abstract, rules does not coincide with reasoning on arbitrary rules.

A further piece of evidence for this hypothesis is provided by the results of a neglected, but interesting experiment by Mosconi and D'Urso (1974; see also Mosconi, 1990). In the early seventies, the common explanation of content effects on reasoning was that casting problem in realistic terms *facilitated* the logical interpretation of the problem and so led to the correct solution. According to Mosconi and D'Urso, this generic facilitatory effect of realism was questionable. Realistic material could not facilitate logical reasoning simply because, in realistic conditions, subjects were not solving logical problems, but answering realistic questions. Therefore, Mosconi and D'Urso argued, it was possible to devise experimental tasks in which the solution of the realistic problem would have been logically incorrect. For this reason, they modified the original Johnson-Laird *et al.*'s (1972) postal problem. The modification itself was minimal: the *not-q* envelope carried a 150 lire stamp rather than the 40 lire of the original version. Now, this stamp, although different from that stated in the rule ('*If the letter is sealed, then it has a 50 lire stamp on it*'), does not represent its pragmatic negation: Someone who paid 150 lire instead of just 50 lire cannot, of course, be considered as a potential violator! In other words, an envelope carrying a 150 lire is not, pragmatically, a *not-q* case, rather, using the authors' definition, it is a *super-q* case. With this modification of material, while keeping constant all the other aspects of the task, Mosconi and D'Urso found that most of

their subjects (about 70%) chose only the 'sealed envelope'. That is, their subjects selected only the *p* case, exactly as Jackson and Griggs' subjects in the abstract permission conditions. So, both with familiar and abstract deontic rules, subjects make the same error of omitting a card formally representing the *not-q* case, on the basis of the same pragmatic principle: do not select what appears to be irrelevant.

In conclusion, the reviewed empirical findings corroborate the hypothesis that people often reason by using abstracted clusters of rules such as permission and obligation schemas. The degree of abstraction of pragmatic schemas, however, is relative. Even if these knowledge structures can be distinguished from representation of specific experience, they do not attain so high a degree of abstraction as syntactic inference schemas. Pragmatic schemas are in fact *context-sensitive* ; consequently, the outcome of their production rules may not coincide with the result obtained by the application of an inference schema after a formal, non contextual, reading of the sentence being tested. In addition to the described results by Mosconi and D'Urso (1974), this point is supported by some recent findings about children's and adults' reasoning on conditional permissions (Girotto, Gilly, Blaye and Light, 1989) and promises (Light, Girotto and Legrenzi, 1990; Politzer and Nguyen-Xuan, in press). They will be illustrated in the following section.

2.3. Pragmatic schemas and the development of reasoning

How do children learn to solve reasoning problems? The traditional Piagetian approach to the study of reasoning assumes that children learn to reason by acquiring (during adolescence) an internal system of logic with rules closely corresponding to those of standard logic (Inhelder and Piaget, 1958). In this perspective, the ability to assess conditional statements against data (i.e. the ability which is necessary for solving the selection task) is considered a developmentally advanced skill, beyond

young children's competence. Piaget directly hypothesized that only a formal thinker (i.e. an adolescent or an adult) is able to seek a counterexample in order to test the truth of a conditional rule (Beth and Piaget, 1961/1966, p.181).

In a similar way, the authors who accept, to some extent, the Piagetian distinction between the concrete and formal operations stages (e.g. Kuhn, 1977; Moshman 1979; O'Brien and Overton 1980), assume that the ability to correctly assess conditional statements belongs to the more sophisticated formal stage.

According to Braine and Rumain (1983), who interpret the development of reasoning in terms of a gradual acquisition of 'natural' logical abilities different from the Piagetian operations (cf. Braine, 1978), there is a general confirmation bias at the basis of people's failure to solve selection tasks: most subjects, including adults, perform inadequately since they "have a strong bias to evaluate by trying to verify rather than falsify". Even if the source of this bias is not clear, "the poor quality of the performance on these tasks confirms that subjects' logical understanding is reflected more directly on simple deductions than in evaluations and truth judgments" (Braine and Rumain, 1983, p.311).

However, the above results indicating that adults are able to solve selection tasks when presented in terms of social regulations, cast doubt on this pessimistic conclusion, at least as far as adult subjects are concerned. Moreover, since research on the development of social cognition demonstrated that children develop an early sophisticated knowledge of the deontic rules (i.e. the rules which adults are able to evaluate, cf. Turiel, 1983, for a review), we hypothesized that the conditions which facilitate adults' reasoning would produce the same effects on children's reasoning. This general hypothesis has been corroborated by the results of our experiments (Girotto, 1987; Girotto, Blaye and Farioli, 1989; Girotto, Gilly, Blaye & Light, 1989; Girotto, Light & Colbourn, 1988; Light, Blaye, Gilly & Girotto, 1989).

In one of these studies (Girotto *et al*., 1988), we found that 9- to 10-year-olds are able to solve a reduced version of the selection task (the RAST, cf. Johnson-Laird and Wason, 1970; Wason and Green, 1984) when phrased in terms of permission. When an unfamiliar regulation (‘*All the buzzing bees must stay inside’*) was presented as a permission rule made by an authority (the Queen Bee) in order to reach a specific goal (to increase the safety of the bees), about 70% of children solved the task. In another study (Light *et al*., 1989) it has been shown that even for young children (6 to 8 years old) permission rules can dramatically improve performance.

Both these studies used the simplified version of the task. But even with the full selection task, Girotto, Gilly, Blaye and Light (1989) have shown that both 9- to 10- and 14- to 15-year-olds can do quite well in situations concerning permission rules. These results are not easily understandable in terms of the Piagetian theory of formal operations, because no differences in the high rates of correct performance (about 80%) were observed for children at two age levels, one of which corresponded to the Piagetian stage of preformal thinking.

As already mentioned, the study by Girotto *et al*. (1989) also showed that rules contextualised and syntactically cast as permissions can produce patterns of performance which do not coincide with the formally correct one. With unfamiliar permission rules, children's performance turned out to be correct when the relation expressed in the rules did not appear arbitrary, i.e. when an explicit rationale was provided by the experimenter, or when an implicit one was readily available to the children. For example, an unfamiliar permission rule such as '*If one drives over 100 km/h, then one must have a fluorescent car*' elicited a high rate of correct performance (significantly superior to that elicited by the standard rule relating vowels and even numbers), regardless of the presence of an explicit rationale (such as: '*The government decided this law because at high speed cars must be visible at a distance, therefore the fluorescent*

bodywork colour is a safety measure'). With this version of the rule, children were able to imagine, when not explicitly given, a purpose for its formulation. However, when a similar rule (presented with the same context of checking whether people were obeying a road safety rule, and with the same syntactic form) was not intelligible as a permission ('*If one drives under 100 Km/h, then one must have a fluorescent car*'), most children were not able to think of any reason, nor were they able to solve the task. Interestingly, the latter version elicited a higher frequency of erroneous selections of the *not-p* card, which is the card that corresponds to the case '*driving fast*' (i.e. the action that is subject to control in the real world). In conclusion, in deontic versions of the task, children (as well as adults, cf. Mosconi and D'Urso, 1974) search for pragmatically meaningful potential counterexamples, independently of their formal values.

The finding that young children's reasoning on deontic rules can attain a high degree of complexity is consistent with the results of an earlier study (Legrenzi and Murino, 1974) in which it was shown that 6-7 years-old children are able to solve a complete selection task, after training on an unfamiliar but rationalized school rule (‘*If the pupil is a boy, then he must wear a black outfit*’). The interpretation proposed by the authors was based on the 'realism' of the situation, but it is evident that the rule tested is easily interpretable as an obligation (‘*If condition A occurs, then action B must be fulfilled*’).

Our results are also in agreement with another hypothesis about cognitive development. In particular, they are consistent with the demonstration of how children's knowledge of social rules can facilitate their performance in the traditional concrete-operational Piagetian tasks (cf. Doise, 1985). The proposed explanation of these facilitations in terms of '*social marking*' (i.e. the correspondence between the structure of a task or problem on the one hand, and the structure of a particular social relationship or regulation on the other) is similar to the notion of

pragmatic schemas evocation. However, it should be noted that pragmatic schemas comprise both social *and* non social rules (for example, causality rules), and that only a variety of social regulations (the deontic ones), in some cases (i.e. when their structure coincides with the correct conditional reading of the problem), have been proved to facilitate reasoning.

Taken together, the results obtained in our studies support the prediction that the ability to understand the power of potential disconfirmatory data in assessing universal statements is available before adolescence. However, they cannot be considered as empirical evidence of early formal competence in children's reasoning, since an anticipation of the appearance of complex logical abilities could not explain the systematic errors made by adults in the arbitrary versions of the selection task.

2.4. The social contract theory

A different explanation of content effects in reasoning about deontic matters has been proposed by Cosmides (1989; see also Cosmides and Tooby, 1989). According to this author, people use specialized cognitive processes to reason about social exchange, which is defined as an ”adaptive cooperation between two or more individuals for mutual benefit" (Cosmides, 1989). On the basis of evolutionary arguments, she postulates that a specific cognitive process, the ‘ *social contract algorithm’* (henceforth SC algorithm), has naturally evolved. Its aims are (i) assessing the costs and benefits of various courses of action, and (ii) detecting (through a 'look for cheaters' procedure) potential cheaters, i.e. individuals who take the benefit of an exchange and fail to pay the required cost. Without this innate algorithm, Cosmides argues, adaptative social exchanges and therefore the survival of the human species would not have been possible.

From her analysis of the literature on the selection task, Cosmides draws the conclusion that *all* the facilitations of the selection performance were obtained in conditions in which the tested rules were SC's. However, according to Cosmides, these correct performances should not be attributed to a logical interpretation of the task. Consider a SC like '*If you take the benefit, then you have to pay the cost*'. When it is tested in a selection task setting, the activation of the 'look for cheaters' procedure would lead the subjects to select the cards corresponding to an individual who received the benefit and to an individual who did not pay the cost (i.e. the potential cheaters). In the previous literature, facilitation has been proved in situations in which these cards corresponded to the formally correct *p* and *not-q* values. However, following the SC theory, it is possible to predict a different pattern of response: When the 'benefit accepted' and 'cost not paid' will *not* correspond to the *p* and *not-q* values, the subjects would still select them, thus producing a formally incorrect performance.

Cosmides (1989, expts 1-4) found empirical support for this prediction in a series of experiments in which subjects had to solve selection tasks concerning unfamiliar SC rules. They were presented with SC rules such as '*If a man eats cassava root, then he must have a tattoo on his face*' (social law) or '*If you give me your ostrich eggshell, then I'll give you duiker meat*' (private exchange), where cassava root and ostrich eggshell were described as a rationed benefit (for the men to whom the contract had been offered in the first case, and for the man who proposed the contract in the second case). Similarly, having a tattoo and giving duiker meat were described as costs to be paid (to the authority in the first case, to the men to whom the contract has been offered in the second case). When this type of SC rule was stated in the standard formulation ('*If one takes the benefit, then one (must) pay the cost*') [4] subjects selected the formally correct cases

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4 As it can be seen, the two rules do not equally match the general SC form. The *private exchange* is actually a conditional promise. It can be interpreted as a SC only if

p ('*benefit accepted*') and *not-q* ('*cost not-paid*'). By contrast, when the SC rules were switched (e.g. '*If a man has a tattoo on his face, then he eats cassava root*' or '*If I give you duiker meat, then you must give me your ostrich eggshell*'), that is when the rules had the form '*If one pays the cost, then one (can) take the benefit*', the cards more frequently selected were still those representing the cases '*cost not-paid*' and '*benefit accepted*'. But, in this condition, they correspond to the formally incorrect cases *not-p* and *q* [5]. Thus, reasoning about a social rule seems to be governed by a 'look for cheaters' procedure, irrespective of the formal status of the rule components.

SC's are defined as a *subset of permissions* (Cosmides, 1989, p. 236), more precisely, as the only permission rules which provide "robust and

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considered from the promisee'(s) point of view. A private exchange fitting the SC form from the point of view of the speaker would be the following permission'*If you take my duiker meat , then you must give me your ostrich eggshell'*. Similarly, the *switched private exchange* ('*If I give you duiker meat, then you must give me your ostrich eggshell*') is an obligation, which can be read as indicated by Cosmides only from the point of view of the people to whom the contract has been offered. A rule fitting the general switched form from the speaker's point of view is the following promise: '*If you give me your ostrich eggshell, then you can take my duiker meat'*. By using these two forms, it would have been possible to avoid the methodological flaw of having different syntactic formulations for social and private exchanges. The results indicated that subjects have followed the interpretation proposed by Cosmides. This is probably due to the fact that the person *offering* the contract was presented as the potential cheater. It is likely that different instructions would have produced different interpretations of the rule and, therefore, different selections (see below).

[5] It should be noted that, contrary to her claim, Cosmides was not the first researcher to find that in a thematic condition people select the formally incorrect *not-p* and *q* cards. In the above described paper, Mosconi and D'Urso (1974) reported the discovery of the same *not-p* and *q* pattern (58% of the subjects), in a version of the task in which the Johnson-Laird et al.'s (1972) postal rule was transformed in a sort of conditional promise ("*If the envelope is unsealed, then it has a 40 lires stamp on it"*). The theoretical reasons for introducing this change were not based on evolutionary considerations. As indicated, Mosconi and D'Urso aimed to test the hypothesis that, in realistic conditions, people are solving realistic problems and that the elicited performances are not *per se* logically correct.

replicable" facilitations in the selection task. In a second series of experiments, Cosmides (1989, expts 5-9) found that permission rules lacking the benefit-cost requirement structure of an SC produce less facilitation than rules having this structure.

According to Cosmides, these data corroborate her hypothesis that *only* SC permissions facilitate the task, and that the cost/benefit representation of SC's is psychologically real, whereas the more general level of representation in terms of action/condition advocated by Cheng and Holyoak (1985) does not have psychological reality.

Cosmides' claims have produced a lively debate in the literature (cf. Cheng and Holyoak, 1989; Girotto, Blaye and Farioli, 1989; Manktelow and Over, 1990a, 1990b). In the following section, the theoretical and empirical arguments which have been used for contesting the SC theory will be briefly reviewed.

2.5. Social contracts and pragmatic schemas

As Cheng and Holyoak (1989) have shown, the SC theory has a major weakness. In order to explain facilitation obtained in situations where there are no really *exchangeable entities* to give in payment for some individual (or group), the SC theory should be modified in what Cheng and Holyoak defined the *pseudo-SC* theory. Consider, for example, the indicated drinking age rule '*If a person is drinking beer, then the person must be over 19*' (Griggs and Cox, 1982, 1983). Consider also other prudential rules, like the described road safety rules used by Girotto, Gilly, Blaye and Light (1989)[6]. In these cases, the regulations typically express the *requirement* to meet in order to be entitled to do a certain action (e.g. the fluorescent colour of the bodywork is a necessary requirement for the action of driving fast). The facilitation elicited by these rules can be

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6 Facilitation of adults' selection performance with prudential permission rules of this type has been independently obtained by Manktelow and Over (1990a).

explained only under a *broad definition* of SC, that is, considering a SC as 'an exchange in which an individual is required *to pay a cost (or meet a requirement)* to an individual (or group) in order to be eligible to receive a benefit from that individual (or group)' (Cosmides, 1989, p. 197; emphasis added). However, this broad definition of exchange does not really differ from the definition of permission schemas: In this case, Cosmides' 'benefits' become a subset of Cheng and Holyoak's 'actions to be taken' in their (not necessarily contractual) permission schemas, and her 'requirements' become the 'preconditions' of the same schemas. Therefore, in order to avoid that its explanatory power be weakened, the SC theory has been reduced to a specific case of the pragmatic schemas theory.

On the other hand, following the narrow definition of SC, it is impossible to explain the facilitation obtained with rules not involving social exchange. Consider, for example, the prudential rules mentioned above. Although the necessity of meeting the requirement could be considered in itself as a sort of cost, it has been shown that facilitation can be elicited even with prudential problems in which it is clearly specified that the required precaution is *not costly* ('*If one is going out at night* [The tribe believes that vicious spirits roam the night], *then one must tie a small piece of volcanic rock* [which is abundant and free on the islands of the tribe] *around one's ankle'*, Cheng and Holyoak, 1989).

Let us consider now the 'benefit' part of a SC. According to Cosmides' (1989) definition:

> In a social exchange it is not strictly necessary that each side suffer a cost in the course of providing a benefit to the other side (although this will usually be the case); what is essential is that each side be provided with a benefit. This providing of a benefit to the other party is ***required*** [author's emphasis], and usually (although not necessarily) entails a cost. (p. 235, n.8).

By contrast:

> *A permission rule is also a social contract rule only when subjects interpreted the "action to be taken" as a rationed benefit, and the "precondition to be satisfied" as a cost requirement.* [author's emphasis] (p. 237).

Following these definitions, one can predict that only in situations in which a *rationed benefit* can be perceived by *both* parties, should there be the activation of the look-for-cheaters procedure and, therefore, the elicitation of the content effects. If this were the case, then one could still claim (with the caveat about the cost/requirement definition) that SC's are the specific subclass of permission and obligation rules which produce 'reliable and robust' content effect on the selection task. However, the results of an experiment of ours with 7-years-old children (Girotto, Blaye and Farioli, 1989, expt. 3) have shown that this is not the case.

In our analysis, the main problem with the SC theory concerned the fact that it does not separate permission and obligation rules. Cosmides, in fact, conflated the two schemas, considering them distinguishable only by a "minor" difference in terms of "time relation" (Cosmides, 1989, p.234)[7]. This definition, however, is not correct. On the one hand, time relation cannot distinguish permissions and obligations. There are in fact permission rules in which the required condition must be satisfied *after* the accomplishment of the wanted action (e.g. '*If you want to play, then afterwards you must tidy up your room*'). That is, there are permission rules in which a desired action requires the fulfilment of a *post*-condition. On the other hand, in a conditional obligation, the consequent specifies the (usually costly) action(s) to take in response to an antecedent situation which may occur *independently* of the will of the subject (e.g. '*If you are*

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[7] "If the action the rule obligates one to take must be done first (i.e. if it is a *pre*condition [author's emphasis]) the permission schema is activated; if the rule allows that action to be second, then the obligation schema is appropriate" (Cosmides, 1989, p. 234).

sick, then you must stay inside'). Thus, obligation situations typically do *not* involve social exchanges under both narrow and broad definitions. In particular, in the above example, the condition stated in the antecedent (being sick) cannot be considered as a benefit for the subject. Therefore, following the SC theory this rule should not elicit a facilitation effect on the selection task.

Contrary to this prediction, we found that a rule of this type ('*If a bee is sick, then it must stay outside*') and a SC permission rule with a clear cost/benefit structure ('*If a bee wants to buzz, then it must stay outside*') produced statistically equivalent facilitation relative to an arbitrary rule (Girotto, Blaye and Farioli, 1989, expt. 3). The finding that such an obligation rule elicited an high rate of correct performance (58%) is damaging for both Cosmides' definitions of SC: no rationed benefit for *any* of the parties are likely to be perceived in such a situation. It is difficult to consider an illness as a benefit. What else could count as a benefit in this case? Individuals *following* the rule (being sick and staying outside) would not get any benefit apart from the personal satisfaction of being altruistic (preventing baby-bees inside the hive from getting ill). An individual benefit could only be obtained by those who (intentionally) *violate* the rule. One might still argue that the cost/benefit representation does not concern the obligation rule in question, but a *meta*-SC in which the obligation rule stands for the consequent clause : '*If an individual wants the benefit of belonging to the community, then if it is sick, then it must stay outside*'. True, one might always put obligation and permission rules in a meta-SC format with this socio-biological flavour. Therefore, one might always find an individual benefit in *following* a non-SC regulation such as our obligation rule (i.e. the benefit of belonging to the community). However, the interpretation of all regulation rules in terms of a meta-SC would make the SC theory rather loose. Moreover, the effort of translating all regulation rules in this type of representation could *not* be successful. There are, in fact, obligation rules which are not representable

in cost/benefit terms not even in this loose sense. Consider the following (unfortunately) plausible obligation: '*If a man is black, then he must stay outside*'. The difficulties of a cost/benefit reading of this rule need not, I think, be further discussed.

Before concluding this section, it should be noted that the evidence supporting Cosmides' claim that permission rules lacking a cost-benefit structure of an SC produce less facilitation than rules having this structure, is not decisive. As Cheng and Holyoak (1989) have shown, in the related experiments (Cosmides, 1989, expts 5-9), the non-SC permissions were accompanied by a context which did not make clear that they actually were permission rules.

In summary, both from theoretical arguments and empirical evidence, Cosmides' claim that *only* SC with a clear cost/benefit structure can yield facilitation, turned out to be false. On the one hand, the reviewed literature has shown that a number of permission and obligation rules which do not involve any kind of social exchange have produced facilitation. In other words, it has been shown that the cost/benefit structure of SC's is *not necessary* for eliciting the predicted content effects. On the other hand, evidence from two recent studies about reasoning with conditional promises demonstrate that this structure is *not even sufficient* for eliciting the predicted effects. This point will be illustrated in the following section.

2.6. Reasoning on conditional promises: look for plausible cheaters

Consider a conditional promise. Typically, it has the following form: '*If you satisfy the precondition P, then I will give you the reward Q (or I'll give the permission of taking the reward Q*)'. As noted by Politzer and Nguyen-Xuan (in press), this type of contract expresses the obligation to which the *promisor* (the speaker) has committed him/herself, and the permission in which the *promisee* (the hearer) is involved. Now, if a

conditional promise is checked in a selection task setting (where the cards will represent: '*Precondition P is fulfilled by the promisee*', card *p* ; '*Precondition P is not fulfilled by the promisee*', card *not-p* ; '*The reward Q is to be given by the promisor*', card *q* ; '*The reward Q is not to be given by the promisor*', card *not-q*), there will be different interpretations of the task as a function of the role played by the subject. If the subject has to take the role of the promisor (checking for the possible cheating behaviour of the promisee), the test-sentence will evoke a *permission* schema (i.e. a set of rules specifying the promisee's *permission*, e.g. '*If the reward Q is to be given by the promisor, then the promisee must fulfil the precondition P*'). In this case, the pragmatically correct solution of the task will be the selection of the two cases representing the possible infringement of the rule by the promisee (e.g.'*The reward Q is to be given by the promisor*', card *q* ; and '*Precondition P is not fulfilled by the promisee*', card *not-p*). If the subject has to take the role of the promisee (checking for the possible cheating by the promisor), the test-sentence will evoke an *obligation* schema (i.e. a set of rules specifying the promisor's *obligation*, e.g. '*If the precondition P is fulfilled by the promisee, then the promisor must give the reward Q*'). In this case the correct solution will be the selection of the cases where the violation of the obligation by the promisor is possible (e.g. '*Precondition P is fulfilled by the promisee*', card *p,* and '*The reward Q is not to be given by the promisor*', card *not-q*).

As it can be seen, following this interpretation, it is possible to predict, on the basis of the activation of two schemas, the same general patterns of response (*p* and *not-q* ; and *not-p* and *q*) predicted by the SC theory for the standard and switched SC's. This is not surprising, given that (cf. note 4) the private SC's used by Cosmides (1989) were actually conditional promises. In particular[8], the so-called standard SC '*If you give me your*

[8]As already noted (cf. note 4), the so-called switched private SC was presented in an *obligation* form. This is precisely the reading of the rule that the subjects are supposed to make when they have to test a promise from the promisees' point of view. In other

ostrich eggshell, then I'll give you duiker meat', is a promise, for the control of which the subjects (who had to take the promisees' point of view) regularly (about 70%) selected the relevant cards: *p* ('*Ostrich eggshell given to the speaker*'; i.e. '*Precondition P fulfilled by the promisee*', or in Cosmides' term, '*Benefit taken by the speaker*') and *not-q* ('*Duiker meat not given to the hearers*'; i.e. '*The reward Q is not to be given by the promisor*', or '*Cost not paid by the speaker*').

Recently, Politzer and Nguyen-Xuan (in press) have run an experiment using a selection task in which a conditional promise was tested in different conditions. The two principal conditions were produced by keeping constant the rule itself, while changing the point of view of the actors (promisor vs promisee). The variation was introduced by using a scenario of a sale promotion and the rule '*If the purchase exceeds 10,000 Francs, then the salesman must stick a voucher gift on the back of the receipt*'. The subjects were asked how the customers (the promisees) or, alternatively, the manager (the promisor) should verify that the rule had been correctly applied.

Despite the clear cost-benefit structure of the rule, most selection patterns turned out to be different from those predicted on the basis of the SC theory: There was a moderate frequency (35%) of *p* ('*High value receipt*') and *not-q* ('*No gift voucher*') selections in the consumer condition, and a still more moderate frequency (17%) of *not-p* ('*Low value receipt*') and *q* ('*Gift voucher*') selections in the manager condition. These rates are far below the high rates (70%) obtained by Cosmides (1989). A possible explanation of this difference is in terms of the *plausibility of the cheating behaviour* in the two scenarios. On the one hand, in the jewellery scenario it was not obvious how and why the salesman-promisor could default on giving gift-vouchers to deserving customers, and even less

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words, by switching the original promise, Cosmides (1989) obtained the *not-p* and *q* pattern of response, which coincides with that predicted by the present interpretation on the basis of the variations of the actors' point of view.

obvious how customers-promisees could get gift-vouchers they had not 'earned'. The difficulty of representing the violations[9] that the subjects were asked to check, may explain why in Politzer and Nguyen-Xuan's study many of the subjects selected more than two cards, or selected the cards named on the rule (matching bias, cf. note 1). On the other hand, Cosmides' conditions were rather explicit: her promisor was described not only as prepared and able to act dishonestly but also as having great need himself of the reward he was promising. In other words, it was clearly specified why and how the promisor could have cheated. Thus, differences in the representation of the potential violations, turned out to be a powerful factor for explaining selection performance on problems concerning conditional promises, which, following the SC theory, were equally representable in cost/benefit term. This conclusion is strengthened by the results of another study.

Light, Girotto and Legrenzi (1990) presented 11-12-year-olds with a promise made by a teacher to her pupils: '*If you get at least 10 points, then you can have a sweet*'. In one condition, the subjects had to test whether the rule had been violated by the agent of the promise, i.e. a pupil delegated by the teacher to administer her promise. Since they were primed to check whether this agent breached the rule by retaining for himself the reward (the sweets) which had been duly earned by the promisees, the cards to be selected would be those representing a deserving pupil (i.e. one who fulfilled the precondition of getting 10 points, *p* card), and a pupil who didn't obtain the reward (i.e. the promised sweet, *not-q* card). This condition is similar to the private standard SC conditions in Cosmides' (1989) study, and to the 'check the promisor' condition in Politzer and Nguyen-Xuan's (in press) study. In all three

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[9] It should be noted that in this case subjects were requested to make sure that the rule was '*honestly applied*' (consumer role), or '*carefully applied*' (manager role). That is, in both cases, contrary to Cosmides's conditions, the instructions indicated potential violations which could be the result of some unintentional mistake, rather than intentional frauds.

cases, in fact, the correct solution is the selection of *p* ('*Precondition P fulfilled by the promisee*') and *not-q* ('*The reward Q is not to be given by the promisor*') cards, or in SC theory, the selection of the 'cost paid by the promisee' and 'benefit not received by the promisee' cards. As the adults' performance in the jewellery problem, children's performance in Light *et al*.'s study turned out to be different from that predicted by the SC theory: only 22% of children selected just the two mentioned cards. As in the previous case, this performance can be explained in terms of information concerning the goals and the motivations of the potential cheater. First of all, the subjects in Light *et al*.'s study were not provided with information about the cheater's *personality*, nor did they know whether he was *motivated* in keeping for himself the promised reward, which, in any case, was not something that he owned. Secondly, the instructions did not clarify the *nature* of the potential violation. In facts, many children selected more than two cards, and often explained their choices by attributing *nepotistic* intentions, (rather than only selfish intentions) to the agent. Thus, they explained, he could had breached the rule, for example, by giving the reward to an underserving friend (in this case, the selections included the 'sweet' *q* card). Finally, when the representation of the possible violations was made clear, children's performance turned out to be different, i.e. the same as that predicted by the SC theory in terms of the activation of a 'look for cheaters' procedure. This was the case of a second condition in Light *et al*.'s study, in which children were requested to check whether the *pupils-promisees* had violated the teacher-promise. In this case, the promisees acted *alone* and *could* actually attribute to themselves the reward even when underserving. Most of the children (50%) selected the cards corresponding to the cases: '*Precondition P is not fulfilled by the promisee*' (or '*Cost not paid by the promisee*'), card *not-p* ; and '*The reward Q is to be given by the promisor*' (or '*Benefit taken by the promisee*'), card *q* .

In conclusion, the ensemble of these results show that, despite the possibility of recognizing a situation as one of SC (*sensu* Cosmides), reasoning performance can dramatically change as a function on the level of information explicitly or implicitly available concerning the goals and motivations of the actors who could have infringed the rule. These results are easily explained in terms of the pragmatic reasoning schemas approach. Pragmatic schemas are, by definition, clusters of *context-sensitive* rules related to goals and actions, so they will produce different performances as a function of the violations which the context makes plausible.

Recently, a similar explanation has been independently proposed by Gigerenzer and Hug (1990). According to these authors, the crucial issue about SC's is the *cheating option,* i.e. the possibility that a rule can be cheated by one of the parties involved, and the *perspective* that the subject has to take, i.e. the role of one of the parties. If the subject is not in the condition of taking the perspective of someone who could be cheated, the fact that a rule is interpreted as a SC is *not sufficient* for eliciting a high proportion of the responses predicted by the SC theory. In a series of experiments, Gigerenzer and Hug found that, despite the cost/benefit structure of the tested rules, only when the subjects are cued into the perspective of one party and the other party has a cheating option, "then a 'look for cheaters' algorithm is activated that selects the conjunction *benefit taken* and *cost not paid (requirement not met)*". This finding and the focus on the notions of 'cheating options' and 'perspectives' are in agreement with the results and the interpretation discussed here[10] . Where

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10 Similar results have also been independently obtained in a recent study by Manktelow and Over (in press a; see also Manktelow and Over, in press b). Although their interpretation is based on the mental model theory, their results are in agreement with the present interpretation. In particular, they found that a rule very similar to that used by Politzer and Nguyen-Xuan (1990), i.e. '*If you spend more than 100 £, then you may take a free gift*', elicits consistent patterns of selection performance. Now, it should be noted that their scenario, like those of Cosmides but unlike that of Politzer and

they differ is about the *necessity* of having a SC structure for obtaining robust content effects. As it has been discussed, theoretical and empirical reasons suggest that a cost/benefit structure is not necessary for obtaining those effects. In fact, a number of rules which do not involve any kind of social exchange have proved facilitatory. The second point of difference concerns the claim that the pragmatic schemas theory cannot account for the reported results since it is not linked with the notion of perspectives and parties. In the present perspective, the theory does make predictions in terms of perspectives and options, since, as indicated, the definition of pragmatic schemas includes context-sensitivity, goals and actions. Therefore, the pragmatic schemas theory, beside explaining the results discussed in 2.4 which are damaging for the original and the revised SC theories, *can* explain the results about perspectives and parties.

3. Conclusions

This paper has presented a discussion of recent research on how knowledge of subject matter affects conditional reasoning, both in inferential and meta-inferential tasks. A central finding of the reviewed literature is that deontic contents (i.e. those related to the concepts of permission and obligation) elicit specific reasoning performances. In particular, some deontic rules turned out to facilitate the selection task (Wason, 1966), which is, despite its formal simplicity, a very difficult task for most subjects. A theory which deals with the specific role of the deontic rules has been presented in detail. According to the pragmatic schemas theory (Cheng and Holyoak, 1985, 1989; Cheng *et al*., 1986),

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Nguyen-Xuan, *did* make clear the goals and motivations of the actors who could have infringed the rule ('*Times are hard, people don't have much money, and your firm is struggling to survive*'). In other words, as predicted by our interpretation, Manktelow and Over's results confirm that a deontic rule can elicit different selection performance as a function of the degree of plausibility of the potential violation produced by the scenario.

people solve reasoning problems concerning deontic matter, by using abstract knowledge structures that consist of clusters of context-sensitive rules defined in terms of actions and goals. Several studies both with adults and children subjects have corroborated the theory. In particular, a decisive experiment by Cheng and Holyoak has demonstrated that even an abstract statement of a permission rule can facilitate the selection performance. By contrast, a recent study (Jackson and Griggs, 1990) appeared to show that this facilitation cannot be attributed to the activation of a permission schema, but it is due to the linguistic form of the material. This finding, which has been considered one of the most challenging points for the theory in several critical appraisals of it (cf. Eysenck and Keane, 1990, Chapter 12; Johnson-Laird and Byrne, in press, Chapter 4; Rips, 1990), has been discussed at length, along with the results of a study showing how it could be interpreted in terms of the theory. The predictions stemming from the theory in the developmental field have been compared with the contrasting predictions of Piagetian and neo-Piagetian models, and the results of a series of experiments (e.g. Girotto *et al.*, 1988; 1989) confirming the former have been presented. Finally, the theory has been compared with the social contract theory (Cosmides, 1989; Cosmides and Tooby, 1989) which deals with the same range of phenomena. According to the social contract theory only a specific subclass of deontic rules (i.e. the SC rules with a cost/benefit structure) elicit 'robust content effects' on the selection task. The comparison has demonstrated that successful reasoning performance can be obtained even in conditions which *cannot* be represented in the cost/benefit terms of a SC, and that conditions which can be represented in these terms do *not* necessarily elicit the pattern of responses predicted by the social contract theory. In general, the pragmatic schemas theory seems to explain more parsimoniously a larger amount of content effect in reasoning outside the realm of social contracts, in both social and non-social domains.

The theoretical and empirical comparison between the pragmatic schemas and the social contract theories has indicated the complexity of the deontic domain as well as the necessity for a systematic analysis of it. For example, it would be very useful for future research in this field to have a taxonomy of the social exchanges from which one could predict reasoning performance, avoiding the vagaries of the definitions often presented in the literature.

In conclusion, the pragmatic schemas theory has been corroborated by the results of several studies. Whether it is a general theory of reasoning is beyond the scope of this paper. However, it should be noted, on the empirical side, that it needs to be tested on a larger range of problems than just conditional evaluation and rephrasing tasks or the selection task. In addition, the notion of pragmatic reasoning schemas is probably not in itself sufficient to explain differences in performance which seem to depend on the *form* of the reasoning problems, independently of the considered content (cf. Evans, 1989). On the theoretical side, the relationship between pragmatic schemas theory and the more general-purpose theories of reasoning (i.e. mental models theory, cf. Johnson-Laird and Byrne, in press; rules of inference theory, cf. Braine, 1990; Politzer, 1986) has still to be fully analyzed. Future research will clarify these empirical and theoretical points. In the meanwhile it is possible to conclude that the deontic domain plays a distinctive role in affecting reasoning performance, and that the pragmatic schemas theory has merit in explaining in an economical manner the content effects on reasoning produced by this and other real-world knowledge domains.

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