DOI: http://dx.doi.org/10.5334/pb-48-4-283
Psychologica Belgica
2008, 48-4, 283-301.

THE EFFECTS OF INSTRUCTIONS ON REASONING WITH STEREOTYPICAL PREMISES

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This study examined conditional reasoning with premises referring to associations between professions and traits that were either stereotypical ("Accountants like mathematics") or counter-stereotypical ("Nurses like mathematics"). In the first study, participants were asked to rate the degree of certainty of MP and AC inferences based on an individual's profession ("John is an accountant") or based on an individual trait ("John likes mathematics"), under pragmatic instructions or under strong logical instructions, using a context that required them to put themselves in the position of a fictitious actor. Results showed that both forms of inference were rated as more certain with stereotypical premises than with counter-stereotypical premises and that logical instructions increased the overall strength of inferences without reducing the difference between the two forms of premise. The second study presented both stereotypical premises and inferences with believable and unbelievable conclusions, with no additional context. Participants were given inferences under pragmatic instructions followed by logical instructions, or only under logical instructions. Results show that ratings for both MP and AC inferences were higher for stereotypical than counter-stereotypical items, with a similar difference for inferences with belief-consistent and belief-inconsistent conclusions. Logical instructions clearly reduce the influence of premise type, on both types of problems. Receiving pragmatic instructions initially reduced overall levels of normative responding for stereotypical, but not for classical belief-bias inferences. Individual differences in responding indicate that the debiasing effect of logical instructions depends on initial level of bias shown under pragmatic instructions. The results are interpreted as supporting dual-process theories of reasoning.

Logical reasoning involves making deductions on the basis of some given premises that are considered to be true. Logical reasoning is, at least in theory, decontextualized, and thus involves the ability to disregard the specific content of premises when generating a conclusion. However, studies examining reasoning have consistently found that people are influenced by

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Preparation of this manuscript was partially supported by grants from the Natural Sciences and Engineering Research Council of Canada (CRSNG) to the second author and by grants from the Belgian French Community (ARC 06/11-342 and FNRS-FC 53760) to the third author.

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many extra-logical factors when making inferences. In particular, reasoners' beliefs about the truth or falsity of both premises and conclusions have been found to influence the inferential process (e.g., Evans, 2007; Evans, Barston, & Pollard, 1983; George, 1995; 1997; 1999). These kinds of effects underlie current formulations of dual-process theories (Epstein, 1994; Evans, 2007; Klaczynski, 2000; Stanovich, 1999). In the following studies, we extend these results to the specific case of conditional (if-then) reasoning with stereotypes. This is a particularly interesting topic, since stereotypes strongly influence expectations of behaviour according to the group to which a subject belongs (Fiske, 2000; Leyens, Yzerbyt, & Schadron, 1994; Macrae & Bodenhausen, 2000). Research has shown that the influence of stereotypes is difficult to undo, even when explicit instructions are given (Dumont, Yzerbyt, Snyder, Mathieu, Comblain, & Scaillet, 2003). Thus understanding how people reason with stereotypes can provide some useful insights into the nature of the interaction between reasoning competence and non-logical factors postulated by dual-process theories.

Dual-process theories

Dual-process theories of reasoning suggest that there are two distinct types of cognitive process which characterise reasoning. Although there are many different variants of this theory (e.g., Epstein & Pacini, 1999; Evans, 2007; Klaczynski, 2000; Sloman, 1996; Stanovich, 1999), they generally postulate domain-specific processes (often referred to as heuristic) and domain-general processes (often referred to as analytic). Analytic processes are assumed to be working memory intensive, to require conscious manipulation of some symbolic representation of the inferential problem and they can, at least in principle, lead to the kinds of abstract, decontextualized forms of inference that correspond to the rule-based logical reasoning found in logic textbooks (Evans, 1989; Stanovich, 1999). Heuristic processes use access to experience and knowledge to generate inferences that capitalise on stored knowledge about the world. They are associative, rapid, low-cost and reflect the automatic tendency to contextualize problems by activation of prior knowledge (e.g., Evans, 2003; Stanovich, 1999). A key component of these theories, as applied to understanding the nature of the inferential process, is the idea that even when the analytic system is consciously activated, the heuristic system continues to operate at some preconscious level. When the two systems give different conclusions, there is an internal conflict, which can often lead to a heuristic over-ride of the analytic response, which will in turn lead to non-normative responses.

Much of the evidence for the heuristic-analytic division with respect to

inferential reasoning relies on the classic belief-bias effect. Specifically, when given a syllogism with a putative conclusion that is empirically believable, but logically invalid, there is a clear tendency for reasoners to accept the conclusion as valid (Evans et al., 1983). The tendency to do this has been correlated with individual differences in working memory capacity (De Neys, Schaeken, & d'Ydewalle, 2005), as would be expected by these theories. Evans and Curtis-Holmes (2005) found that reducing the time allowed for making an inference increased the belief-bias effect. More directly, De Neys (2006) has recently found that using a concurrent cognitive load increases the tendency to accept believable, but invalid, conclusions.

Study 1

This first study attempted to extend De Neys' (2006) results to inferential reasoning with stereotypes. Stereotypes are pervasive internal representations of dispositional characteristics, attributed to groups (Yzerbyt, Rocher, & Fiske, 1998; Yzerbyt, Rocher, & Schadron, 1997), or in other words, stereotypes are "generalizations about a class of people that distinguish that class from others" (McCauley, Stitt, & Segal, 1980, p. 197). Social stereotypes associated with a particular target's social category can be viewed as a form of *mutual knowledge*, that is information that both communicator and audience implicitly know (Kashima, Klein, & Clark, 2007; Krauss & Fussell, 1996). For example, if an individual is told that someone is an accountant, this individual may assume that he/she is dull and introverted (Evans, 2007). Activation of stereotypes is generally rapid and automatic (Bargh, 1999; Chaiken & Trope, 1999), while "bottom-up" impression formation, involving the processing of the target's individual characteristics, requires more conscious processing (Fiske & Neuberg, 1990). In other words, stereotypes can be taken as implicit beliefs that are automatically activated, and are used when little or no information besides the target's group membership is available (Evans, 2007). In addition, when a target displays both stereotype consistent and inconsistent information, the former tends to be more easily integrated in the emerging impression (see Fiske & Neuberg, 1990; Hamilton & Sherman, 1994, for a review) as well as in memory (Fyock & Stangor, 1994; Stangor & McMillan, 1992).

Our purpose in this study is to examine whether stereotypes also influence deductive reasoning, which explicitly requires deriving a conclusion from specific premises. In particular, we examine deductions that are derived from premises that are stereotypical or counter-stereotypical. In such a case, the use of stereotypes as the major premise might affect the implicit believability of the major premise, which might in turn affect the

inferences that are made (e.g., George, 1995; 1997; 1999; Stevenson & Over, 1995). The items that we used were based on Fiske, Cuddy, Glick, and Xu's (2002) assertion that stereotypes related to professions are captured by two competing, core dimensions; warmth and competence. Many groups are viewed as competent but not warm or the inverse. Specifically, we presented subjects with inferences using premises that were either stereotypical, such as "Computer scientists are introverted", or counter-stereotypical "Computer scientists are warm".

Participants were presented with a description of a task that had to be accomplished by a hypothetical person called Stéphane. Stéphane had a list of four professions, and their possible characteristics, and also separate lists of individuals with either their profession or the profession's characteristics indicated. His task was to use these two sources of information in order to make judgments about the individuals. There were two basic forms of inference. Both started with a major premise associating a profession with a specific characteristic, that was either stereotypical (as in the example below), or counter-stereotypical. The first form of inference presented an individual who shared the same profession, and the inference concerned their personal characteristics (this corresponds to the Modus ponens (MP) form of inference).

Teachers are altruistic
David is a teacher
Can Stéphane conclude with certainty that David is altruistic?

The second presented an individual who shared the same characteristic, and the inference concerned their profession (this corresponds to the Affirmation of the consequent (AC) inference).

Teachers are altruistic
Philippe is altruistic
Can Stéphane conclude with certainty that Philippe is a teacher?

In all cases, participants were asked to respond the conclusion on a scale going from 1 (it is not at all certain) to 9 (completely certain). Our basic hypothesis is that the certainty ratings would be higher with stereotypical premises than with counter-stereotypical premises, for both forms of inference.

Note that we presented the inferential tasks as being performed by a third person, and not directly by the participant. This was done because the general description of the situation (lists of professions, and unrelated lists of traits) was somewhat unlikely, and it may make it easier for participants to engage in the situation (which appeared like a game).

We also decided to vary the instructions given to the participants. Dual-process theories suggest that individuals should exert some conscious control over the relative contributions of the two processes (e.g., Evans, 2007).

One way of evaluating this possibility is to vary the explicit instructions accompanying the task. Hence, we gave participants one of two forms of instructions, *pragmatic*, which emphasised use of personal experience and knowledge, and *logical*, which emphasised making only necessary inferences based solely on information that was presented, with the assumption that everything stated in the problems was true. The logical instructions we used were based on those employed by Vadeboncoeur and Markovits (1999). They examined reasoning with premises that were not necessarily true, and found that there was a clear tendency for reasoners to reject the MP inference in this case (see also George, 1995; 1997; 1999; Stevenson & Over, 1995), but that very strong logical instructions eliminated this effect.

We can specifically predict that strong logical instructions should thus increase reasoners' use of analytic processing. However, exactly what kind of effect this will have remains an open question. If we generalise directly from Vadeboncoeur and Markovits (1999), we would predict that the overall degree of certainty for the MP inferences would increase. We would also predict that the difference between the stereotypical and counter-stereotypical premises would decrease, if not disappear. However, several studies have shown that, when given instructions requiring them not to think in stereotypical terms, participants gave more stereotypical judgments, indicating that the accessibility of stereotypical information can increase under explicit instructions (Dumont et al., 2003; Macrae, Bodenhausen, Milne, & Jetten, 1994). If it is assumed that one of the effects of logical instructions is to promote processing of premises that is not sensitive to empirical knowledge, then we would be less certain about this second prediction. Finally, we can make a prediction about the effect of instructions on the AC inference. The simplest interpretation of dual-process theory would suppose that increased analytic processing should be associated with an increase in normative responding. This would lead to the prediction that certainty ratings on the AC items should decrease with logical instructions. However, as Evans (2007) notes, it may not be appropriate to make a simple equation between analytic processing and normative responding.

Method

Participants

A total of 73 students attending a French-speaking university in Brussels participated in this study (37 women, 36 men; average age: 26 years, 11 months). Participants came from mixed European backgrounds and were from middle to lower-middle class neighbourhoods.

Materials

Sixteen versions of a basic five-page booklet were constructed. On the front page of each questionnaire, participants were asked to indicate their age and sex, directly followed by task instructions. Task instructions in the *pragmatic* condition were as follows:

"Stéphane is a student who was presented with profiles of individuals, each having one of the following professions: Nurse, accountant, computer programmer, and teacher. He has another list with the individual's names and some information about them. Unfortunately, Stéphane doesn't know how to combine the two lists. He tries to make conclusions based on this information in order to produce a single list containing the names, professions and personal characteristics of each individual."

"Stéphane tried to derive the best conclusions possible. To do so, he used his personal knowledge and experience."

"You are going to be presented with some of conclusions derived by Stéphane. You will be asked to indicate if, according to you, those conclusions are certain (on a scale from 1 to 9)."

Task instructions in the *logical* condition were identical, except that the way that Stéphane arrived at his conclusions was described in the following terms:

"*Stéphane tried to derive conclusions that were logically valid*. For each problem, he considered *that everything that was written was true*. Then he had to decide if a given conclusion could be *logically derived* from the presented affirmations."

"*A conclusion can be logically derived from preceding affirmations if this conclusion is absolutely certain when the affirmations are true*."

Following task instructions, and starting on the next page, 16 reasoning problems were presented. These were constructed in the following way. Half of these were in the MP form. The premises used for these 8 problems consisted in pairing each of the 4 professions (nurse, teacher, programmer, and accountant) with one stereotypical and with one counter-stereotypical trait. The premises used for the 8 AC problems were constructed in the same way. The 16 problems were constructed so that no single trait appeared more than one time.

The specific traits used in this study were taken from a study by Waroquier and Klein (2007) which examined stereotypical traits associated with various professions in the same population as that examined here. The traits stereotypically associated with computer programmers and accountants were: introverted, materialist, likes computers, and likes mathematics. The traits stereotypically associated with nurses and teachers were: altruist, irrational, warm, and attentive to people.

Four booklets were constructed in which both the order of the problems

(which alternated randomly between the MP and AC forms) and the specific premises used (subject to the constraints mentioned above) were varied. These used masculine names. Four other booklets were constructed that were identical to the initial four, but used feminine names. These 8 booklets were presented with both pragmatic and logical instructions, giving a total of 16 booklets.

Results

An initial analysis determined that there was no effect of the sex of the characters named in the problems, nor of the order of presentation. These were thus excluded from the subsequent analyses. Mean certainty ratings for the MP and AC inferences with stereotypical and with counter-stereotypical traits as a function of type of instruction are presented in Table 1. A repeated-measures ANOVA was performed using mean conclusion rating as dependent variable with Form of problem (MP, AC) as a repeated measure, with Type of trait (Stereotypical, Counter-stereotypical) as a repeated measure and Instructions (Pragmatic, Logical) as independent variables. This indicated a significant main effect of Form of problem, $F(1, 71) = 39.95$, $p < .001$, a significant main effect of Type of trait, $F(1, 71) = 45.29$, $p < .001$, and a significant main effect of Instructions, $F(1, 71) = 6.56$, $p < .02$. There was also a significant form of problem × type of trait interaction, $F(1, 71) = 7.25$, $p < .01$.

Table 1
Mean ratings for conclusions on the MP and AC inferences by type of major premise (stereotypical, counter-stereotypical) and type of instruction (pragmatic, logical)

		MP		AC	
Instructions	N	Stereotypical	Counter-stereotypical	Stereotypical	Counter-stereotypical
Pragmatic	41	4.14	3.26	2.41	1.89
Logical	32	4.84	4.05	3.06	2.54

Analysis of the main effect of Form of problem indicated that the degree of certainty was higher for MP ($M = 4.12$) than for AC ($M = 2.52$). Analysis of the main effect of Type of trait indicated that the degree of certainty was higher for problems with Stereotypical ($M = 3.66$) than Counter-stereotypical traits ($M = 2.98$). Analysis of the main effect of Instructions indicated that the degree of certainty was higher for Logical ($M = 3.62$) than Pragmatic instructions ($M = 2.93$). Post hoc analyses of the interaction between Form

of problem and Type of trait interaction, using a Tukey post hoc procedure with $p = .05$, indicated that the difference between stereotypical and counter-stereotypical premises was significant for both AC and MP forms, although the absolute difference was larger for the latter than the former.

These results indicate some clear effects of both the nature of the premises and the kinds of instructions used, although their interpretation is somewhat complex. In order to provide a better description of just what might be happening, we decided to examine the results in more detail. We looked at participants whose overall ratings of the MP and AC inferences were similar for stereotypical and counter-stereotypical premises, and those whose ratings were different. Specifically, we grouped participants whose combined ratings on the MP and AC inferences for the stereotypical and counter-stereotypical premises were within .5 of each other into the *unbiased* group, and those whose ratings differed by more than this into the *biased* group. Table 2 indicates the mean certainty ratings for the two groups.

Table 2
Mean ratings for conclusions on the MP and AC inferences by type of major premise (stereotypical, counter-stereotypical) and instructions (logical, pragmatic) for biased and unbiased participants

			MP		AC	
	Instructions	N	Stereotypical	Counter-stereotypical	Stereotypical	Counter-stereotypical
Biased	Pragmatic	20	4.65	3.10	2.90	2.09
	Logical	24	4.52	3.03	3.24	2.31
Unbiased	Pragmatic	12	3.30	3.5	1.60	1.56
	Logical	17	5.28	5.49	2.81	2.85

We then looked at whether the proportion of *biased* and *unbiased* participants varied according to the type of instructions given. A chi-squared analysis indicated that there was no significant difference in the proportion of *biased* participants under pragmatic instructions ($M = 62.5\%$) and under logical instructions ($M = 58.5\%$), X^2 (1) = 0.73, *n.s.* Following this, a repeated-measures ANOVA was performed using Form of problem (MP, AC) as the dependent variable, with Type of trait (Stereotypical, Counter-stereotypical) as a repeated measure and Instructions (Pragmatic, Logical) as the independent variable, for both *biased* and *unbiased* participants. For *biased* participants, there were main effects of Form of problem, $F(1, 42) = 27.13$, $p < .001$, and Type of trait, $F(1, 42) = 122.59$, $p < .001$, and a form of problem × type of trait interaction, $F(1, 42) = 15.49$, $p < .001$. There was no effect of Instructions. For *unbiased* participants, there were main effects of

Form of problem, $F(1, 27) = 17.81$, $p < .001$, and Type of instruction, $F(1, 27) = 9.73$, $p < .01$. Post hoc analyses indicated that the increase in overall MP and AC ratings were significant for *unbiased* participants.

Discussion

Overall, these results clearly show that stereotypes significantly influence deductive reasoning, with participants accepting inferences more strongly when these were based on stereotypical premises. There was a clear effect of the type of instructions used in the task description. Specifically, logical instructions raised the overall level of acceptance of the conclusions for both MP and AC inferences, but did not affect the relative difference between stereotypical and counter-stereotypical premises, which remained as strong with logical instructions as with the pragmatic instructions. Finally, the results suggest that reasoners differ in the extent to which they are subject to stereotypical bias under both forms of instruction.

Study 2

In this second study, we extend our initial results in two directions. We first presented the problems as direct inferences, without asking participants to put themselves in another person's situation. While the scenario used in the first study was designed to make the inferences more plausible, this also introduces an extra layer of social and cognitive complexity. We hypothesised that asking these inferences more directly might make it easier for participants to reason logically. We also wished to examine the potential interaction between pragmatic and logical instructions in more detail. Specifically, we gave participants a set of problems using pragmatic instructions, followed by the same problems using logical instructions, with a subset receiving only the second set under logical instructions. Our working hypothesis was that making the contrast between the two forms of instruction more explicit would increase the effect of logical instructions, and decrease the effect of belief-bias. One explanation of how this effect might be obtained might suggest that such a design might increase the efficiency with which reasoners are able to monitor potential conflicts between heuristic and logical conclusions (e.g., De Neys & Glumicic, 2008; Evans, 2007; Stanovich & West, 2008). However, a dual-process framework might allow the opposite prediction, i.e., that initiating heuristic processing might make subsequent logical reasoning more difficult. We also used this design to look more closely at the nature of the individual differences in susceptibility to bias and instructional effects, by using a within subjects design. Finally,

we examined more typical belief-bias items, where putative conclusions are consistent or inconsistent with knowledge (e.g., tigers are dangerous, kittens are dangerous), in order to look at whether effects related to stereotypes differ from those found on previous studies.

Method

Participants

A total of 210 students attending a French-speaking university in Montreal participated in this study (133 women, 77 men; average age: 22 years, 8 months). Participants came from mixed European backgrounds and were from middle to lower-middle class neighbourhoods.

Materials

Eight versions of a basic five-page booklet were constructed. On the front page of each booklet, participants were asked to indicate their age and sex, directly followed by task instructions. In the full version, initial instructions were a simplified form of the pragmatic instructions used previously:

"You will be asked to respond to several problems of inference and to indicate if, according to you, the presented conclusions are certain (on a scale from 1 to 9). In order to do this, you must use *your personal knowledge and experience*."

Following task instructions, and starting on the next page, 8 reasoning problems were presented. Half of these were in the MP form, the other half in the AC form. Half of the booklets employed *Stereotypical* content. These problems were a subset of those used in the first study, and paired one of the four previous professions (nurse, teacher, programmer, and accountant) with one stereotypical and one counter-stereotypical trait (two professions for each of the two logical forms). The MP, the AC form, the stereotypical and the counter-stereotypical premise were systematically alternated over the 8 problems. The other half of the booklets employed inferences typically used for belief-bias studies, which have putative conclusions that are believable or unbelievable. These will be referred to as *Knowledge-based* content. These also alternated between MP and AC forms, with believable and unbelievable conclusions. These were:

1. If something is smoked, then it is bad for one's health. Cigarettes are smoked. Cigarettes are bad for one's health. (MP believable)
2. If an animal is dangerous, then it has teeth. Kittens have teeth. Kittens are dangerous. (AC unbelievable)
3. If something is eaten, then it is bad for one's health. Spinach is eaten. Spinach is bad for one's health. (MP unbelievable)
4. If something is a flower, then it has roots. Roses have roots. Roses are

flowers. (AC believable)
5. If something is smoked, then it is good for one's health. Cigarettes are smoked. Cigarettes are good for one's health. (MP unbelievable)
6. If an animal is dangerous, then it has teeth. Lions have teeth. Lions are dangerous. (AC believable)
7. If something is eaten, then it is good for one's health. Spinach is eaten. Spinach is good for one's health. (MP believable)
8. If something is a flower, then it has roots. Trees have roots. Trees are flowers. (AC unbelievable)

Following the initial set of problems, participants were then asked to respond to a second set of inferential problems and were given logical instructions similar to the ones used in the previous study:

"You will be asked to respond to several more problems of inference. For each problem, you must consider *that everything that is written is true*. You will be asked to indicate if, according to you, the presented conclusions can be *logically derived* from the presented affirmations. *A conclusion can be logically derived from preceding affirmations if this conclusion is absolutely certain when the affirmations are true*. You will be asked to rate the certainty of the presented conclusions (on a scale from 1 to 9)."

Following this on the next page, the same 8 problems (in different order) were given to participants.

A sub-set of the booklets only presented logical instructions followed by the second set of inferential problems. This gave a total of 4 booklets, corresponding to two forms of content (Stereotypical, Knowledge-based) and two conditions (pragmatic instructions followed by logical instructions, logical instructions only). For each booklet, a second version was also constructed that was identical except that the order of the inferential problems was inverted in each set.

Results

For the sake of brevity, we will refer to stereotypical and believable conclusions as consistent items, while counter-stereotypical and unbelievable items will be referred to as inconsistent items. Mean certainty ratings for the MP and AC inferences with consistent and inconsistent conclusions as a function of Condition (logical only, pragmatic followed by logical) and Content (stereotypical, knowledge-based) are presented in Table 3.

Table 3
Mean ratings for conclusions on the MP and AC inferences by content (stereotypical, knowledge), type of major premise (consistent, inconsistent), instructions (pragmatic, logical) and condition (pragmatic followed by logical, logical only)

			Pragmatic Instructions				Logical Instructions			
			MP		AC		MP		AC	
Condition	Content	N	Consistent	Inconsistent	Consistent	Inconsistent	Consistent	Inconsistent	Consistent	Inconsistent
Pragmatic followed by logical	Stereotypical	73	3.49	2.18	2.19	1.84	5.20	4.79	2.82	2.57
	Knowledge	77	4.95	2.27	4.91	2.61	6.21	4.94	5.77	4.32
Logical only	Stereotypical	29					6.69	5.03	5.74	4.19
	Knowledge	31					7.06	6.84	1.81	1.81

Direct effects of instruction

We first examined the direct effects of instructions by looking at performance on both the MP and AC inferences for both stereotypical and knowledge-based items on the first set of items in both conditions (i.e., under initial pragmatic instructions and initial logical instructions). We performed an ANOVA with mean rating of the conclusion for the first set of problems as dependent variable with Consistency and Logical Form as repeated measures and Condition and Content as independent variables. This indicated significant main effects of Content, $F(1, 206) = 24.16$, $p < .001$, Condition, $F(1, 206) = 62.06$, $p < .001$, Consistency, $F(1, 206) = 94.61$, $p < .001$, Logical form, $F(1, 206) = 93.61$, $p < .001$, and significant interactions involving consistency × condition, $F(1, 206) = 9.64$, $p < .01$, consistency × content, $F(1, 206) = 36.81$, $p < .001$, logical form × condition, $F(1, 206) = 60.27$, $p < .001$, form × condition× content, $F(1, 206) = 22.42$, $p < .001$, and logical form × consistency, $F(1, 206) = 7.60$, $p < .001$. All post hoc analyses used the Tukey test with $p = .05$.

The main effect of Consistency indicates that overall, consistent items are rated more highly ($M = 4.31$) than inconsistent items ($M = 2.87$). In order to better quantify the difference between consistent and inconsistent items, we also calculated a *bias* score (which was the mean rating for consistent items minus the mean rating for inconsistent items). The interaction between Consistency and Condition showed that the effect of consistency was greater under pragmatic instructions (*bias* $M = 3.37$) than under logical instructions (*bias* $M = 1.67$). In other words, logical instructions reduced (but did not eliminate) the overall bias in conclusion ratings when compared to pragmatic instructions.

Analysis of the interaction between Consistency and Content showed that all pair-wise comparisons were significant. Comparison of *bias* scores indicated that relative bias was greater with Knowledge based items (*bias* $M = 4.50$) than with Stereotypical items (*bias* $M = 1.24$). Examination of the interaction between Logical form and Consistency indicated that the *bias* score was greater on the MP inferences (*bias* $M = 1.70$) than on the AC inferences (*bias* $M = 1.19$).

Analysis of responding to the two logical forms across both types of item showed that ratings on the MP inferences were higher than those on the AC inferences. The interaction between Logical form and Condition indicated that overall ratings for the MP inferences under logical instructions ($M = 6.43$) were significantly higher than under pragmatic instructions ($M = 3.23$), while no such difference was observed for AC inferences (logical instructions: $M = 3.33$; pragmatic instructions: $M = 2.91$). Analysis of the three way interaction showed that the increase in MP ratings under logical instructions was present for both contents (although this increase was larger with the Knowledge-based items than with Stereotypical items). However, Knowledge-based items also showed a significant increase in AC ratings under logical instructions ($M = 4.96$) than under pragmatic instructions ($M = 3.76$), while no such difference was observed with Stereotypical items, which showed an opposite trend, although not one that was significant (pragmatic: $M = 2.01$; logical: $M = 1.81$).

Effects of receiving preliminary pragmatic instructions

We then examined the effect of receiving pragmatic instructions on subsequent responding under logical instructions. We performed an ANOVA with mean acceptance of the conclusion for consistent and inconsistent MP and AC inferences under logical instructions as dependent variables with Consistency and Logical Form as repeated measures and Condition and Content as independent variables. This indicated significant main effects of Content, $F(1, 205) = 15.61$, $p < .01$, Consistency, $F(1, 205) = 47.62$, $p < .001$, and Logical form, $F(1, 205) = 103.40$, $p < .001$, and significant interactions involving consistency × content, $F(1, 205) = 26.48$, $p < .001$, logical form × content, $F(1, 205) = 47.76$, $p < .001$, logical form × condition, $F(1, 205) = 13.45$, $p < .001$, and logical form × condition × content, $F(1, 205) = 7.95$, $p < .001$. All post hoc comparisons were done using the Tukey test with $p = .05$.

Overall, combined MP and AC ratings were lower with consistent ($M = 5.11$) than with inconsistent items ($M = 4.26$), and lower for Stereotypical items ($M = 8.03$) than for Knowledge based items ($M = 10.68$). Analysis of the interaction between Logical form and Content showed that AC ratings for Knowledge based items ($M = 5.03$) were significantly higher than AC ratings for Stereotypical items ($M = 2.43$), while no difference was found between MP ratings for

Knowledge based items ($M = 5.65$) and for Stereotypical items ($M = 5.60$).

The key analyses concerned effects related to Condition. Analysis of the interaction between Logical form and Condition showed that MP ratings were significantly higher when only logical instructions were given ($M = 6.26$) than when logical instructions were preceded by pragmatic instructions ($M = 5.30$), while AC ratings were lower when only logical instructions were given ($M = 3.34$) than when logical instructions were preceded by pragmatic instructions ($M = 3.92$). Analysis of the interaction between Logical form, Condition and Content showed that these differences were only significant for Stereotypical items (logical only: MP = 6.95; AC = 1.81; pragmatic followed by logical: MP = 5.01; AC = 2.70), but not for Knowledge based items (logical only: MP = 5.86; AC = 4.97; pragmatic followed by logical: MP = 5.57; AC = 5.04), for which condition had no effect on overall MP and AC ratings. In other words, for Stereotypical, but not for Knowledge-based items, initially making inferences under pragmatic instructions has the effect of making both the MP and AC inferences less normative under subsequent logical instructions. No effects were observed on degree of bias.

Individual differences

Finally, we looked at individual differences in pragmatic responding and how these were related to subsequent reactions to logical instructions. In order to do this, we classed participants into three roughly equal groups. Those whose combined *bias* ratings (combined over both MP and AC forms) under pragmatic instructions were less than 1 were put into the Low bias group; those bias scores were between 1 and 4 were put into the Medium bias group, and those whose bias scores were greater than 4 were put into the High bias group. We then performed an ANOVA with combined bias scores under Logical instructions as dependent variable and Group and Content as independent variables. This gave only a significant effect of Group, $F(2, 142) = 12.43$, $p < .001$. Post hoc analyses showed that bias scores under logical instructions were significantly higher in the *High bias* group ($M = 4.60$) than in the *Medium bias* group ($M = 1.07$) which was significantly higher than in the *Low bias* group ($M = 0.05$).

Finally, we looked at whether the predictive value of degree of bias shown under pragmatic instructions was present with the MP or AC inferences. We performed a regression analysis with total bias score under Logical instructions as dependent variable and bias scores for the MP and AC inferences under Pragmatic instructions as independent variables. This showed that both bias on the AC inferences, $F(1, 145) = 193.17$, $p < .001$, and bias on the MP inferences, $F(1, 145) = 148.83$, $p < .001$, were significantly related to degree of bias shown under Logical instructions.

Discussion

The results of this study allow some interesting conclusions about reasoning with stereotypical premises, and of the effects of instruction. They reinforce the results of the first study that show that reasoners tend to rate conclusions drawn from stereotypical premises as more certain than those drawn from counter-stereotypical premises, for both the MP and AC inferences. The same effect was found when classical belief-bias inferences were used. This latter result is somewhat surprising, since most studies looking at reasoning with knowledge-based items have found little effect on MP inferences (e.g., Evans et al., 1983; although see Markovits & Bouffard-Bouchard, 1992). Since this effect was quite large and was found with both pragmatic and logical instructions, it must be considered robust. The question of the source of the difference between the present results and previous ones remains open, but at the very least, these results show that it is possible to obtain strong belief-bias effects on MP inferences with knowledge-based items.

The results of this study also allow the clear conclusion that, when compared to pragmatic instructions, the logical instructions used here do reduce the difference in degree of acceptance of conclusions based on stereotypical and those based on counter-stereotypical premises, and also the effect of conclusion believability using knowledge-based items. This is in contrast to the results of the first study, which found little effect of instructions on differences in reasoning with stereotypical and counter-stereotypical premises. Since the sole difference between the two studies is in the presentation context used in the first study, this allows the conclusion that this context reduces the effects of logical instructions with stereotypical premises. In other words, asking people to make inferences in a context that requires them to put themselves in the place of a fictitious actor reduces their capacity to make more normative inferences when prompted by explicit logical instructions.

The results of this second study show that logical instructions diminish the effects of bias, both due to stereotypicality and to conclusion belief, when compared to pragmatic instructions, as hypothesised. However, our hypothesis that giving logical instructions directly after pragmatic instructions would increase the debiasing effect of the former was not confirmed. This manipulation had no clear effect on the degree of bias related to consistency. In fact, the results show that receiving pragmatic instructions initially makes subsequent inferences less logically normative overall with stereotypical and counter-stereotypical inferences (for both MP and AC inferences), although not with knowledge-based inferences, for which there is no effect. Thus, this manipulation did not increase participants' awareness of the nature of

the conflict between pragmatic and logical instructions, nor did it have any effect on their ability to monitor conflicts between believable (or stereotypical) conclusions and logical validity (De Neys & Glumicic, 2008; Evans, 2007; Stanovich & West, 2008).

Logical instructions also have overall effects on MP and AC responding when compared with pragmatic instructions. For reasoning with knowledge-based items, logical instructions result in higher ratings of both MP and AC conclusions when compared to pragmatic instructions, thus replicating the results of the first study. However, with stereotypical items, logical instructions increased ratings of MP conclusions, but did not affect AC ratings. This latter pattern of results is similar to those obtained by Vadeboncoeur and Markovits (1999).

Finally, the individual differences analysis shows a clear pattern. Specifically, the degree of bias shown with pragmatic instructions, which explicitly call for use of experience and knowledge, is directly related to the degree of bias shown under logical instructions, for both forms of content. In addition, bias on both MP and AC inferences under pragmatic instructions predict subsequent levels of bias under logical instructions.

Conclusion

The results of these two studies can generally be interpreted within a dual-process framework. Specifically, they indicate the kind of interactions between heuristic and analytic responding (as primed by pragmatic and logical instructions) that are postulated by these theories. First, they show that instructions directly affect the degree of bias due to use of stereotypical premises and to use of empirically believable conclusions, with logical instructions reducing these effects compared to explicitly pragmatic instructions. Second, they show that logical reasoning with stereotypical premises is negatively affected by two different forms of heuristic effects. Comparison between the two studies shows that context (i.e., having a fictitious character make inferences) eliminates the debiasing effect of instructions found with direct presentation of problems. In addition, making inferences under pragmatic instructions reduces overall levels of normative responding to stereotypical inferences (but not to knowledge-based inferences). However, this does not have any effect on the degree of bias shown on either form of inference. Both of these effects clearly show a negative effect of heuristic processing on logical reasoning with stereotypes and with knowledge-based conclusions. In addition, the individual differences analysis clearly shows an interaction between the ways that reasoners respond under heuristic instructions and their responses under logical instructions. They indicate that the

degree of bias shown under heuristic instructions is related to subsequent logical responding, with clear differences in the ability of reasoners to respond differently to both forms of instructions also related to this initial difference.

Finally, these results also raise some interesting questions. First, there are strong effects of knowledge-based conclusion belief on MP inferences in the second study. This appears to contradict other studies which have found that such effects are mostly limited to more complex and uncertain inferential forms (e.g., Evans et al., 1983), and understanding the locus of these differences is important for subsequent studies. A second, but related point, concerns the nature of the individual differences observed in these studies. Our results indicate that degree of bias shown on the MP inferences under pragmatic instructions is a good predictor of individual differences in subsequent logical responding. Current approaches to individual differences in belief-bias effects concentrate on working memory as a key factor (e.g., De Neys et al., 2005). However, working memory does not relate to responding to MP inferences (e.g., Markovits, Doyon, & Simoneau, 2002), which suggests that additional factors might be important to understanding these individual differences.

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Received December 15, 2008
Revision received June 29, 2009
Accepted July 3, 2009