Cognitive Psychology 67 (2013) 98–129

Contents lists available at ScienceDirect

Cognitive Psychology

journal homepage: www.elsevier.com/locate/cogpsych

The compatibility heuristic in non-categorical hypothetical reasoning: Inferences between conditionals and disjunctions

Orlando Espino [a,*], Ruth M.J. Byrne [b,1]

[a] University of La Laguna, Tenerife, Spain
[b] Trinity College Dublin, University of Dublin, Ireland

ARTICLE INFO

Article history:
Accepted 29 May 2013
Available online 22 August 2013

Keywords:
Hypothetical
Conditional
Disjunction
Heuristic
Inference
Reasoning

ABSTRACT

A new theory explains how people make hypothetical inferences from a premise consistent with several alternatives to a conclusion consistent with several alternatives. The key proposal is that people rely on a heuristic that identifies compatible possibilities. It is tested in 7 experiments that examine inferences between conditionals and disjunctions. Participants accepted inferences between conditionals and inclusive disjunctions when a compatible possibility was immediately available, in their binary judgments that a conclusion followed or not (Experiment 1a) and ternary judgments that included it was not possible to know (Experiment 1b). The compatibility effect was amplified when compatible possibilities were more readily available, e.g., for 'A only if B' conditionals (Experiment 2). It was eliminated when compatible possibilities were not available, e.g., for 'if and only if A B' bi-conditionals and exclusive disjunctions (Experiment 3). The compatibility heuristic occurs even for inferences based on implicit negation e.g., 'A or B, therefore if C D' (Experiment 4), and between universals 'All A's are B's' and disjunctions (Experiment 5a) and universals and conditionals (Experiment 5b). The implications of the results for alternative theories of the cognitive processes underlying hypothetical deductions are discussed.

* Corresponding author. Address: Department of Psychology, University of La Laguna, Campus de Guajara, 38205 La Laguna, Tenerife, Spain. Fax: +34 922317461.
E-mail addresses: oespino@ull.es (O. Espino), rmbyrne@tcd.ie (R.M.J. Byrne).
[1] Address: School of Psychology and Institute of Neuroscience, Trinity College Dublin, University of Dublin, Lloyd Building, Dublin 2, Ireland.

0010-0285/$ - see front matter © 2013 Published by Elsevier Inc.
http://dx.doi.org/10.1016/j.cogpsych.2013.05.002

1. Introduction

When Obama warned Congress to accept his proposals about tax cuts or face the ad hoc cuts of the sequester, was it accurate to infer at the time that if Congress accepted his proposals, the sequester would *not* be introduced? Hypothetical inferences of this sort are made without recourse to factual information – at the time it was unknown whether Congress would accept Obama's proposals, and it was unknown whether the sequester would be introduced. They contain no categorical information, and so they require a reasoner to infer a conclusion that is consistent with several alternatives, from a premise that is consistent with several alternatives.

Inferences between conditionals and disjunctions allow a consideration of alternatives in the absence of categorical information that is crucial for genuinely hypothetical prediction (e.g., Wason & Johnson-Laird, 1972). Despite their importance, the past 50 years of research has focused on conditionals and disjunctions separately. It has examined hypothetical inferences anchored by a categorical assertion of fact, e.g., 'If Congress accepts Obama's proposals, the sequester will not be introduced. The sequester was introduced. Therefore, Congress did not accept his proposals.' (e.g., Evans, 1983; Johnson-Laird & Tagart, 1969; Newstead, Griggs, & Chrostowski, 1984; Roberge, 1976, 1977; see Manktelow, 2012 for a review). Almost all research on hypothetical inference has focused on such 'after-the-fact' hypothetical inferences. But in everyday life people also reason in situations in which the facts are not known.

From the instruction: 'Release the clutch gently or the car will stall', does the conclusion 'If I don't release the clutch gently, the car will stall' follow validly? Logicians disagree about whether it should (e.g., Kripke, 1959; Quine, 1974), and psychologists dispute whether, for most logically naïve individuals, it would (e.g., Evans & Over, 2004; Johnson-Laird & Byrne, 2002). Do people make these inferences? The answer remains largely unknown. We report a series of 7 experiments that reveal people's reliance on heuristic processes to do so.

1.1. Inferences between conditionals and disjunctions

Only five empirical observations have been made about how people make inferences between conditionals and disjunctions: Given a claim, e.g. 'there's an Ace in the hand or there's a King', participants rate as highly convincing the conclusion, 'if there's not an Ace, there's a King' (Johnson-Laird & Byrne, 2002; Over, Evans, & Elqayam, 2010). They generate paraphrases of 'A or B' using 'if' readily, more so than they evaluate conclusions based on 'if' (Ormerod & Richardson, 2003; Richardson & Ormerod, 1997). However, given multiple premises, e.g., 'A or B. If B, not not-C. Therefore if not-A, C', they spontaneously make intermediate inferences such as 'if B, C' but less often, 'if not-A, B' (Braine et al., 1995; see also Braine, Reiser, & Rumain, 1984; Osherson, 1975; Rips, 1983). From a sequence of conditionals, e.g., 'if A, B, if B, C' they infer a conditional conclusion, 'if A, C' (Byrne, 1989a; Santamaria, Garcia-Madruga, & Johnson-Laird, 1998), but from a sequence of disjunctions, e.g., 'either A or else B, either B or else C', they find it difficult to make an inference (Johnson-Laird, Byrne, & Schaeken, 1992). And they accept more inferences that contain an affirmative disjunction 'A or B, therefore If not-A, B', compared to a negated disjunction 'Not-A or B, therefore If A, B' (Oberauer, Geiger, & Fischer, 2011).

But these observations have been based on only a few of the possible inference forms between conditionals and disjunctions, and nothing is known about how people make most of the 16 distinct inferences that can be constructed from a conditional of one of four polarities (if A B, if A not-B, if not-A B, if not-A not-B) to a disjunction of one of four polarities (A or B, A or not-B, not-A or B, not-A or not-B), and the corresponding set of 16 inferences from a disjunction to a conditional. Our aim is to provide a systematic and comprehensive examination of the complete set of 32 inferences between disjunctions and 'if A B' conditionals, as well 'A only if B' conditionals, 'if and only if A B' bi-conditionals, and 'All A's are B's' universals, including both inclusive disjunctions, 'A or B or both' and exclusive disjunctions 'A or B but not both'. We propose a new theory for inferences between conditionals and disjunctions based on a heuristic that identifies compatible possibilities. No theory is available that encompasses every sort of hypothetical inference: the scope of ours is to provide a fragment of a new account for