



Conditional sentences create a blind spot in theory of mind during narrative comprehension☆



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ARTICLE INFO

Article history:

Received 12 September 2014

Received in revised form 21 May 2015

Accepted 25 May 2015

Available online 2 June 2015

Keywords:

Conditionals

Theory of Mind

Desire

Discourse comprehension

Eye tracking

ABSTRACT

We identify a blind spot in the early Theory of Mind processing of conditional sentences that describe a protagonist's potential action, and its predictable consequences. We propose that such sentences create expectations through two independent channels. A decision theoretic channel creates an expectation that the action will be taken (*viz.*, not taken) if it has desirable (*viz.*, undesirable) consequences, but a structural channel acts in parallel to create an expectation that the action will be taken, irrespective of desirability. Accordingly, reading should be disrupted when a protagonist avoids an action with desirable consequences, but reading should not be disrupted when a protagonist takes an action with undesirable consequences. This prediction was supported by the eye movements of participants reading systematically varied vignettes. Reading was always disrupted when the protagonist avoided an action with desirable consequences, but disruptions were either delayed (Experiment 1) or recovered from faster (Experiment 2) when the protagonist took an action with undesirable consequences.

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1. Introduction

In order to predict the actions of other people as a narrative or a social situation unfolds, it is necessary to keep track of their beliefs and their desires through online, fast *Theory of Mind* inferences (Kovács, Téglás, & Endress, 2010). Recent studies have shown that the desires of others are consistently at the forefront of an observer's mind (Malle & Holbrook, 2012), even when these desires are complex and conflicting (Ferguson & Breheny, 2011). Avoidance desires, though, seem to pose a problem of their own. An individual has an avoidance desire when he or she wants to avoid some state of the world, rather than to see it realised. Children, adults, and older adults alike find it difficult to track avoidance desires (Apperly, Warren, Andrews, Grant, & Todd, 2011; German & Hehman, 2006; Leslie, German, & Pollizi, 2005). Furthermore, they appear to rely on slow and deliberate mental processes to track avoidance desires, as if fast and automatic processes could not be relied on in these circumstances.

In this article, we employ eye tracking measures of narrative comprehension to show that avoidance desires hide in a blind spot of our fast, automatic Theory of Mind (cf. Haigh & Bonnefon, 2015, for an

application of this method to approach desires). We consider narratives that describe the potential action (P) of a protagonist, as well as its predictable consequences (Q), under the form of a conditional sentence ("if P, then Q"). The literature we review suggests that these sentences create expectations through two separate channels, whose output can diverge. This divergence can in turn lead readers to expect actions that contradict the avoidance desire of the protagonist. We test this model in two eye tracking experiments that recorded various measures of reading fluency for systematic variations of the narrative.

1.1. The decision-theoretic channel

Let us consider a conditional sentence describing the potential action of a protagonist, as well as the desirable (1a) or undesirable (1b) consequences of that action:

(1a) Jayne said to Robert "If I have oysters for my main course, I'll be a very happy lady";

(1b) Jayne said to Robert "If I have oysters for my main course, I will be very ill".

What do we expect Jayne to do? Most people predict that Jayne will do what serves her interest best (Bonnefon, 2009, 2012; Bonnefon & Hilton, 2004; Bonnefon & Sloman, 2013). That is, a majority of people who read 1a predict that Jayne will have the oysters – and a majority of people who read 1b predict that Jayne will avoid the oysters.

☆ This work was supported by an Experimental Psychology Society (EPS) Small Grant awarded to the first author. The EPS had no role in study design, the collection, analysis and interpretation of data, the writing of the report or the decision to submit the paper for publication.

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In other words, a “utility” conditional (Bonnefon, 2009) such as 1a or 1b creates an expectation that the protagonist will make the antecedent true when its consequent is desirable (if P then desirable Q; therefore, protagonist will do P), and it creates an expectation that the protagonist will make the antecedent false when its consequent is undesirable (if P then undesirable Q; therefore, protagonist will do not-P). Readers expect that protagonists will take actions that lead to positive consequences, and not take actions that lead to negative consequences. These expectations are rational if we assume that others will act in a self-interested manner, by taking actions that increase their personal utility and avoiding actions that would decrease their personal utility (Bonnefon, 2009).

This view is what we call the *decision-theoretic* channel: conditional sentences create expectations about the truth or falsity of the antecedent based on the desirability of its consequences. Expectations delivered by the decision-theoretic channel are a textbook example of Theory of Mind inferences: Based on the mental states assigned to the protagonist (a desire to attain or avoid the consequent, and a belief that the antecedent will realise or prevent the consequent), an inference is derived about whether or not the protagonist has the intention to perform the action described in the antecedent. Conditional sentences, however, can create expectations based on another channel, independent of Theory of Mind, that we call the *structural channel*.

1.2. The structural channel

In parallel to reasoning tasks featuring utility conditionals (with desirable or undesirable contents), other studies focused on the Event Related Potentials (ERPs) associated with reading neutral-content conditionals (Bonnefond & Van der Henst, 2009, 2013). One key aspect of these studies is that they compared conditionals followed by a sentence that matched the antecedent (as in 2a), to conditionals followed by sentences that mismatched the antecedent (as in 2b):

- (2a) If John is sleeping, then he is snoring; John is sleeping;
 (2b) If John is sleeping, then he is snoring; John is singing.

These ERP studies provide consistent evidence that people who read a conditional “if P then Q” expect that P is true. Reading that P is true as in 2a prompts a P3b component (which is typically associated with expected stimuli) whereas reading about a different action (as in 2b) prompts a N2 component (which is typically associated to unexpected stimuli). This is more than just a simple (mis)match effect as readers do not expect to be told that Q is true (John is snoring), even though it is explicitly mentioned in the conditional rule (Bonnefond et al., 2012).

These findings suggest that P may be the fast acting, default expectation following a conditional of the form if P then Q; a claim that is supported by most psychological theories of conditionals (e.g., Evans & Over, 2004; Johnson-Laird & Byrne, 2002; Sperber & Wilson, 1995). These theories share the assumption that the first step of representing a conditional statement is to assume that the antecedent (P) is true. Note that this expectation seems independent of the desirability of P and Q, which played a critical role in the decision-theoretic channel. It appears that the mere structure of the conditional triggers expectations that the antecedent must be true. From a decision theoretic perspective, this expectation is rational when the consequences of an action (P) have neutral or positive utility, but may be not be rational where the action has consequences with negative utility (e.g., assuming that Jayne will have the oysters even though they will make her ill).

This is what we call the structural channel: conditional sentences create uniform expectations about the truth of the antecedent, irrespective of desirability.

1.3. Two channels make for a blind spot in Theory of Mind

We propose that conditional sentences create online expectations based on two parallel channels. When people read a conditional sentence “if P then Q”, they form an expectation that P is true through the structural channel, and they also form a decision theoretic expectation that P is true (viz., false) when Q is desirable (viz., undesirable). What are the consequences for online narrative comprehension? Let us look at four combinations of sentences:

1. “If I have oysters for my main course, I’ll be a very happy lady”. With this in mind she decided to *order* the oyster special.
After reading the conditional, the structural channel creates an expectation that Jayne will have oysters, and the decision-theoretic channel does the same. Accordingly, readers should have no problem processing a subsequent region of text that describes Jayne ordering the oyster special.
2. If I have oysters for my main course, I’ll be a very happy lady”. With this in mind she decided to *avoid* the oyster special.
The structural channel creates an expectation that Jayne will have oysters, and the decision-theoretic channel does the same. The subsequent description of Jayne avoiding the oyster special is therefore in violation of the expectations created by both channels, and should thus create substantial reading disruption.
3. “If I have oysters for my main course, I will be very ill”. With this in mind she decided to *order* the oyster special.
This is the combination where Theory of Mind may be susceptible to a blind spot. The structural channel creates an expectation that Jayne will have the oysters, but the decision-theoretic channel creates an expectation that she won’t. This means that readers must simultaneously anticipate P and not-P, thus not precluding any action. Therefore, reading disruption may be minimal even though the protagonist is taking an ostensibly irrational action.
4. “If I have oysters for my main course, I will be very ill”. With this in mind she decided to *avoid* the oyster special.
The structural channel creates an expectation that Jayne will have the oysters, but the decision-theoretic channel creates an expectation that she won’t. Again the reader must simultaneously anticipate P and not-P. Because the subsequent sentence describes a rational action, reading should not be disrupted.

Predictions based on parallel structural and decision theoretic channels have implications for how we understand online Theory of Mind processing. Compare the second and third vignettes, which both describe the protagonist acting against her best interests. In the second vignette (which implies an approach desire), we expect readers to detect that the character acted against her best interest because her action contradicts the expectations of both the structural and decision theoretic channels. However, in the third vignette (which implies the avoidance desire of not getting ill) the parallel channels build opposite expectations (P and not-P), thus not precluding any action. As a result, people may not easily detect that the character acted against her best interest. This essentially creates a Theory of Mind blind spot for avoidance desires during online processing, consistent with previous findings that suggest avoidance desires are especially difficult to process.

To test our prediction, we created narrative vignettes similar to the Jayne example, in which the decision theoretic and structural channels produced either matching or conflicting predictions about the truth of the antecedent. To reveal how these channels influenced online processing, we analysed the eye movements of participants as they read follow up sentences to the conditional, that either asserted the truth (P) or the falsity (not-P) of its antecedent.

2. Experiment 1

Participants were presented with a series of vignettes containing conditional sentences describing a protagonist’s potential action (P) and

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