What triggers exhaustivity in answers to wh questions? Evidence from TOM impairment after right hemisphere damage

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This study explored the nature of exhaustive readings in single and multiple wh-questions. We investigated whether exhaustivity in answers to these wh-questions is based on grammatical (i.e. semantic-syntactic) knowledge or on the ability to evaluate which information the interlocutor asking the question is seeking. To date single and multiple wh-questions have mostly been considered separately, and it is still unclear whether the exhaustivity requirements stem from the same source. Therefore, we systematically compared the interpretation of single wh questions (*Who is painting?*) and multiple wh-questions (*Who is painting what?, Who is giving what to whom?*).

It may be that exhaustivity in both single and multiple wh-questions results from taking into account the interlocutor's perspective and deciding on the optimal answer given the context and the interlocutor's intention. For single wh-questions, this account has been spelled out by van Rooij (2004) and Zimmerman (2007), who suggested that wh-questions are underspecified as to whether they require an exhaustive answer. Within this framework, a person answering a wh-question needs to take into account the specific context in which the question is being asked, including the speaker's intention, and then may or may not answer with an exhaustive list. We argue that Theory of Mind (TOM), the ability to evaluate the interlocutor's intention, is required in order to adequately decide whether an answer should be exhaustive. The same mechanism could, in principle, hold for multiple wh-questions as well. Alternatively, exhaustivity in single and multiple wh-questions may result from different mechanisms, requiring TOM abilities only for single wh-questions. Multiple wh-questions have been argued to generally presuppose a more-than-one-answer context (e.g., Dayal, 2005). Thus, in the majority of languages (including Hebrew), multiple wh-questions, modelled using universal quantification, obligatorily trigger exhaustive paired-list answers (cf. Krifka, 2001). Multiple wh-questions have only one reading and thus require only grammatical knowledge; TOM abilities are not necessary to arrive at a target-like interpretation. Within semantics accounts, single wh-questions, on the other hand, are ambiguous regarding their demand for exhaustivity (Nelken & Shan, 2004; Schulz & Roeper, 2011; Schulz, in press). The exhaustive reading is derived when the question domain is universally exhausted; the mention-some reading is derived from an existential quantification over the question domain (cf. Nelken and Shan, 2004; Nishigaushi, 1999). Thus, consideration of the interlocutor's point of view and her intentions is necessary to choose between the mention-some and the mention-all interpretation of a single wh-question.

To explore these alternatives to exhaustivity in wh-questions, we tested exhaustivity in single and multiple wh-questions with individuals who exhibit Theory of Mind (TOM) impairment (aTOMia); these are individuals who as a result from focal brain damage or from traumatic brain injury show an impairment in their ability to evaluate the speaker's intentions (cf. Blake, 2006;

2007; Happé, Brownell, & Winner, 1999). The participants were 21 brain-damaged adults, 17 of them with TOM impairment and 4 with normal theory of mind, and 10 adult controls. The TOM ability of the brain damaged participants was tested using the aTOMia battery (Balaban, Ziv & Friedmann, 2010). Using 16 different items, the battery tests different aspects of TOM (including first order false belief, second order false belief, understanding various social situations that include a knowledge gap between the protagonists and mental cartoons). Exhaustivity was tested with the question-with-picture task by Schulz (in press), comprising 30 pictures with multiple characters, which perform different actions (i.e., eating, drinking, sitting), combined with single wh-questions (i.e., Who is holding a soccer ball?), multiple wh-questions (i.e., Who is drinking what?), and triple wh-questions (i.e., Who is giving what to whom?).

The healthy controls and the brain-damaged individuals with normal TOM provided exhaustive answers to all questions (non-aTOMics and adult controls: 100% correct in single, paired, and triple). The aTOMic individuals did not consistently exhaust. They performed lower on single wh-questions (M = 81.7%; SD = 18.4%) than on paired wh-questions (91.1%, SD = 8.5%) and triple wh-questions (100%). The difference between the single and multiple answers was statistically significant (T = 1, p = .002). This pattern of results demonstrates a clear dissociation between the single and multiple wh-questions regarding exhaustivity, the aTOMic patients showed difficulty in providing exhaustive answers only to single wh-questions. This indicates that the ability to exhaust in single wh-questions requires consideration of the others' point of view. Importantly, the same aTOMic patients were able to provide appropriate exhaustive answers to both paired and triple wh-questions suggesting that exhaustivity in multiple wh-questions does not rely on ToM ability. These results provide strong evidence for the assumption that exhaustivity in single and multiple wh-questions is triggered by different mechanisms: the former based on TOM abilities and the latter based on grammatical abilities. Future research has to investigate whether finding the optimal answer or finding the adequate of two readings is the underlying mechanism of deriving (non)exhaustivity in single wh-questions. In sum, this study demonstrates that testing individuals who sustained brain damage and show impairment in TOM (alongside preserved syntactic abilities) can inform us about the nature of different linguistic structures and their relation. We argue that while TOM is a general cognitive ability that does not affect all aspects of language, TOM impairment leads to linguistic impairment in structures in which there is a need to consider the point of view of others (Balaban, Friedmann, Ariel, & Ziv, 2008; Balaban, Belletti, Friedmann, & Rizzi, in press).

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