Children differ from adults in the interpretation of disjunction: Evidence from an eye-tracking study

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The disjunctive statement $A \text{ or } B$ often engenders two inferences: The speaker knows that the corresponding conjunctive statement $A \text{ and } B$ is false (scalar implicature); and the speaker doesn’t know the truth values of the two domain propositions $A$ and $B$ (ignorance inference). To compare the online processing of the two inferences by children and adults, we conducted an eye-tracking experiment using the visual world paradigm. Participants’ behavioral responses and eye-movements were recorded when they were viewing the test images (Figure 1) and listening to the auditorily presented test sentences (Figure 2).

On each trial, participants first saw images of two animals on the screen, along with the audio of the animals. Next, participants saw a test image consisting of four boxes (Figure 1) and heard a test sentence (Figure 2) via the two speakers. Participants’ task was to locate Xiaoming’s box according to the test sentence and to press the corresponding button as soon as possible. In each test image, participants saw four boxes situated at the four quadrants and two different animals containing in the boxes. Participants were told that the four boxes could vary in two dimensions: its closeness and its size. Note that whether or not a box is closed influences our epistemic knowledge about that box: If a box is open, then the animal(s) contained in that box is known. If a box is closed, then the animal(s) contained in that box is unknown. The size of a box affects the number of animals contained in the box, but not our epistemic knowledge about that box. No matter whether the box is closed or not, a small box always contains one animal, and a big box always contains two different animals.

Given the experimental design, the correct responses to a conjunctive statement (Figure 2a) is the big open box (e.g., Box A in Figure 1). Participants’ responses to the disjunctive statement (Figure 2b), however, depend on how the two inferences are processed. If participants compute neither the scalar implicature nor the ignorance inference, then all the four boxes will be eligible options. If participants compute the scalar implicature but not the ignorance inference, then the big boxes (e.g., Box A and Box C in Figure 1) will be ruled out, and the remaining two boxes B and D will be the eligible options. If participants compute the ignorance inference but not the scalar implicature, then all the open boxes (Box A and Box D in Figure 1) will be ruled out, and the remaining two boxes B and C will be the eligible options. To summarize, the small closed box (e.g., Box B in Figure 1) will not be chosen as the final option of a disjunctive statement until both the scalar implicature and the ignorance inference are computed.

Behavioral responses (Figure 3) reveal that both adults ($n = 36$) and children ($n = 28$, mean age = 5) chose the big open box as the one corresponding to the conjunctive statements, confirming the validity of the responses under other conditions. Regarding their responses to the disjunctive statements, adults always chose the small closed box, suggesting that they computed both the scalar implicature and the ignorance inference. 5-year-old children, however, didn’t give consistent behavioral responses, indicating that they failed to compute the two inferences. The eye-movement data (Figure 4) confirmed the behavioral responses. More specifically, adults computed the two inferences engendered by the disjunction immediately upon encountering the disjunctive connective, i.e., prior to the offset of the disjunctive connective. By contrast, 5-year-olds never considered the closed boxes (i.e., the big closed and the small closed boxes) as the eligible options of the disjunctive statements. To establish at what age children compute both inferences as adults do, we are now testing primary school children using the same task. We will discuss the implications of the current findings for understanding the pragmatic versus grammatical nature of scalar implicatures and ignorance inferences, as well as the acquisition of logical words.
Figure 1. Test Image

Figure 2. Test Sentences

a. And
小明的箱子里有 一只 奶牛和 一只 公鸡
Xiaoming de xiangzi li you yi zhi nainiu he yi zhi gongji
Xiaoming’s box in have one-CL cow and one-CL rooster.

b. Or
小明的箱子里有 一只 奶牛 或 一只 公鸡
Xiaoming de xiangzi li you yi zhi nainiu he yi zhi gongji
Xiaoming’s box in have one-CL cow or one-CL rooster.

Figure 3. Behavioral Responses

Note: The dashed horizontal line signifies the chance level of the behavioral responses, i.e., 25% of the test items. A asterisk implies that the observed behavioral responses are significantly larger than the chance level (***, p < 0.001; **, p < 0.01).

Figure 4. Eye Movements

Note: The two dashed vertical lines signify the onset and the offset of the sentential connectives, respectively. The proportion of fixations are baseline centered, i.e., the diagramed proportions are the original proportion of fixations minus the mean proportion of fixations prior to the onset the sentential connectives. The gray area implies that the observed proportion of fixations are significantly bigger than the chance level (p < 0.05, Bonferroni corrected).