How interaction affects (un)certainty about the partners' perspectives

Xiaobei Zheng (Shenzhen University), Daphna Heller (University of Toronto),
Suzanne Stevenson (University of Toronto) & Richard Breheny (University College London)
xiaobeizheng@szu.edu.cn

The interactivity of a situation affects perspective-taking [1]. Here we demonstrate that the *nature* of the interaction plays a crucial role, even when the *knowledge* that can be attributed to the partners is controlled for. Our proposal is that the multiple-perspectives framework [2], which probabilistically combines the influence of the speaker's and the listener's perspective and explicitly encodes uncertainty about partners' perspectives, provides insight into these effects.

Method: main task. In each trial, participants saw a virtual grid, empty at first (Fig. 1a). Then objects appeared which only they could see, not the Director (Fig. 1b), at which point the preliminary phase took place (more below). Then the mutually-visible objects appeared (Fig 1c). At this point, the confederate Director instructed the participant *"Click on the apple"*; the listener was being eye-tracked. The display either contained a hidden apple (competitor condition; Fig. 2a) or an unrelated object (e.g., strawberry, non-competitor condition; Fig 2b). The experimental conditions across the two experiments differ only in the **preliminary phase**. Right before the instruction phase, all conditions contained evidence that the Director knew the superordinate category (fruit/animals/shapes), but not the specific objects (e.g., apple or strawberry).

Experiment 1. In the **preliminary phase** of the *interaction* condition (n=20), the Director guessed – at chance – the superordinate category of hidden objects (fruit/animal/shape), highlighting the Director's ignorance about listeners' knowledge. In the *baseline* condition (n=20), the participant was asked about the superordinate category of the hidden objects by the computer. **Results.** We calculate target advantage in each condition (Fig 3a): how much the mutually-visible target (apple) is preferred over the hidden competitor or non-competitor (apple/ strawberry). The critical window was noun processing (200-600ms after onset): the difference in target advantage between the competitor and the non-competitor conditions is higher in *baseline* (purple lines) than *interaction* (red lines), indicating that the early interaction led to *less* competition from the hidden apple. We propose that interaction makes listeners more certain about speaker's knowledge. In the multiple-perspectives framework, this translate into more weight on the assumed speaker's perspective and *less* weight on the listener's own perspective (weighting is relative).

This finding raises the question of whether interaction always leads to more certainty about the partner's knowledge, or whether this depends on the specific nature of the interaction. Thus, in **Experiment 2**, we used interactions that did not highlight ignorance, but instead highlighted the knowledgeability of the speaker (while again controlling for knowledge). Exp. 2 has a secondary goal: to tease apart interaction and joint attention to information. **Method.** In the **preliminary phase** of the *interactive-shared* condition (n=20), the Director announced the superordinate category of the hidden objects prior to their appearance, and the listener acknowledged. In the *noninteractive-shared* condition (n=20), both Director and listener were told the category by the computer (listeners knew from practice that directors are also told). The *baseline* condition (n=20) was non-interactive and non-shared. Like in Exp. 1, the information that can be attributed to the Director was the same (the superordinate category of the objects). **Results.** Analysis as for Expt. 1 (Fig. 3b). Interestingly, here interaction had an effect in the opposite direction: the *interactive-shared* condition (red lines) showed the more competition from the hidden apple than the *noninteractive-shared* condition (blues lines), which, in turn, showed more competition than the *baseline* condition (yellow lines). Most importantly, this reveals that interaction does not have a uniform effect of assigning more weight to the partner's perspective. Instead, listeners are sensitive to the specific content of the interaction: When the Director announces the category, this highlights the possibility that they will subsequently tailor their language to the knowledge of the listener, which leads listeners to assign more weight to their own perspective. In addition, these results demonstrate that shared attention and interaction each affect uncertainty, contributing separately to the relative weighing of perspectives.
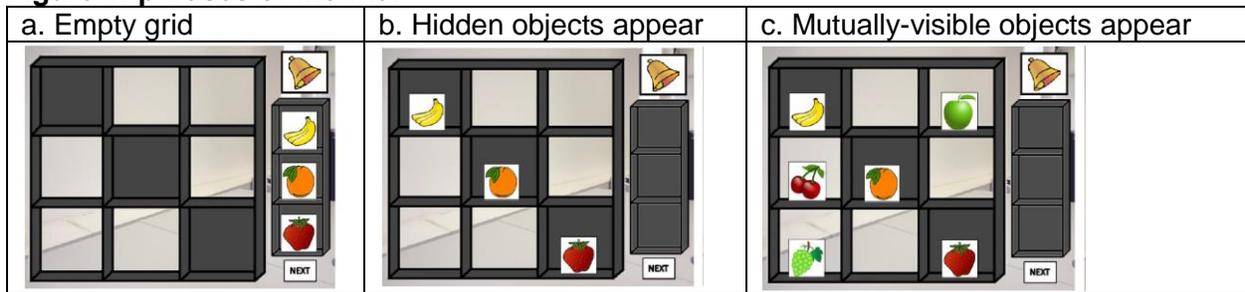
Figure 1: phrases of the trial

a. Empty grid	b. Hidden objects appear	c. Mutually-visible objects appear

Figure 2: Two types of displays

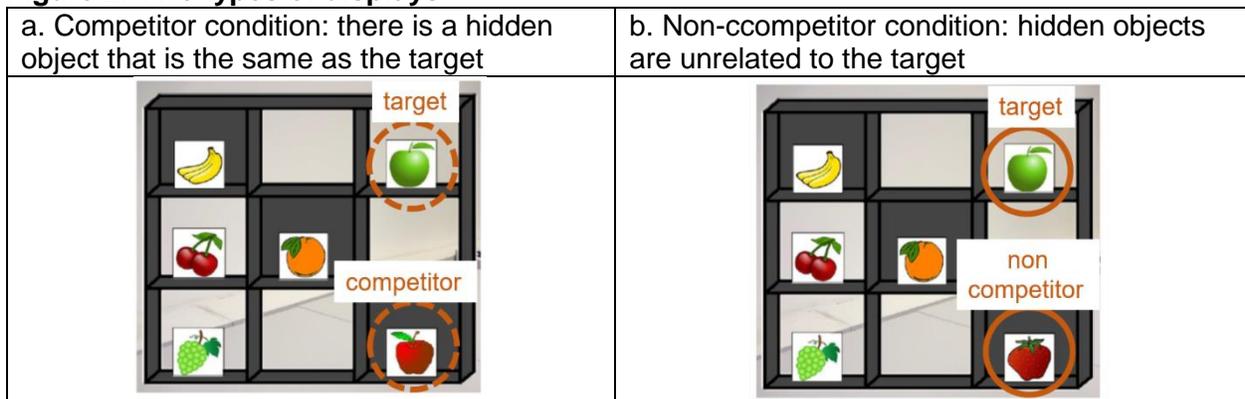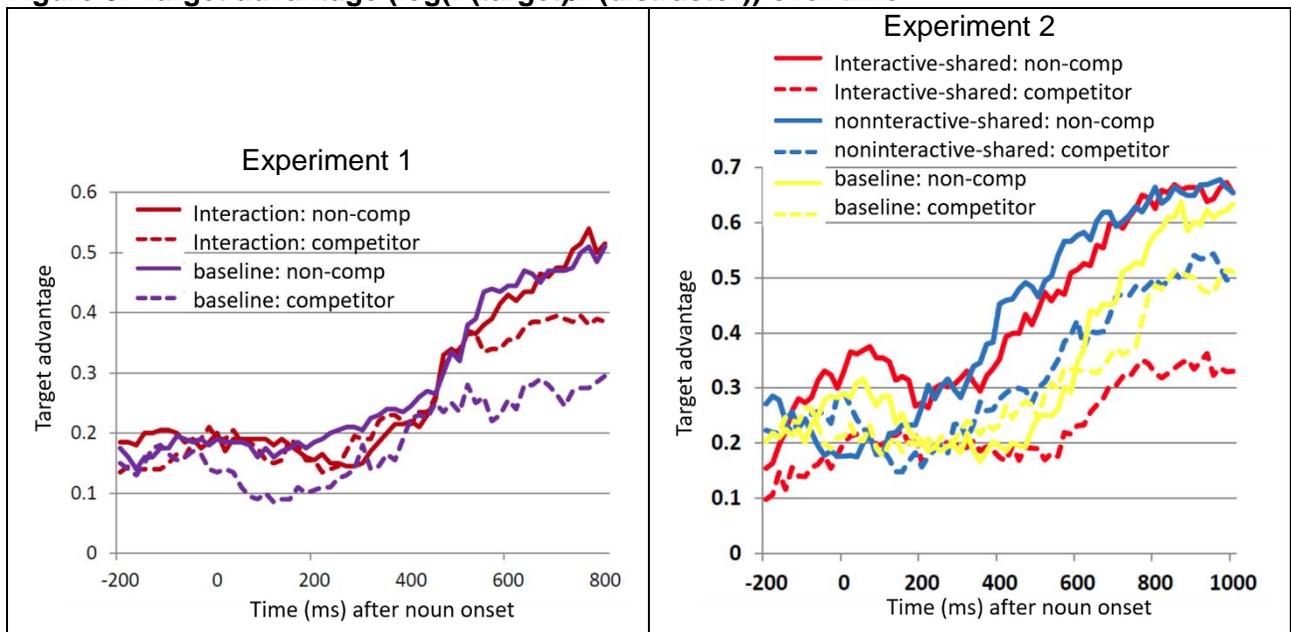| a. Competitor condition: there is a hidden object that is the same as the target	b. Non-ccompetitor condition: hidden objects are unrelated to the target

Figure 3: Target advantage (log(P(target)/P(distractor)) over time

References

[1] Brown-Schmidt, S. (2009a). Partner-specific interpretation of maintained referential precedents during interactive dialog. *Journal of Memory and Language*, *61*, 171-190.

[2] Heller, D., Parisien, C. & Stevenson, S. (2016). Perspective-taking behavior as the probabilistic weighing of multiple domains. *Cognition*, *149*, 104-120.