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Working memory influences the time-course of perspective taking in the Keysar task: an eye-movement study

Introduction

Our ability to infer another's perspective is key to many social situations and interactions, guiding our understanding of others' current mental states: their knowledge, beliefs and intentions [1,2]. Research has demonstrated a link between perspective-taking and executive functions [3]. Here we examined whether the urgency to take another's perspective modulates the effects of working memory load (WML) on perspective-taking ability using a modified 'Keysar task' [4].

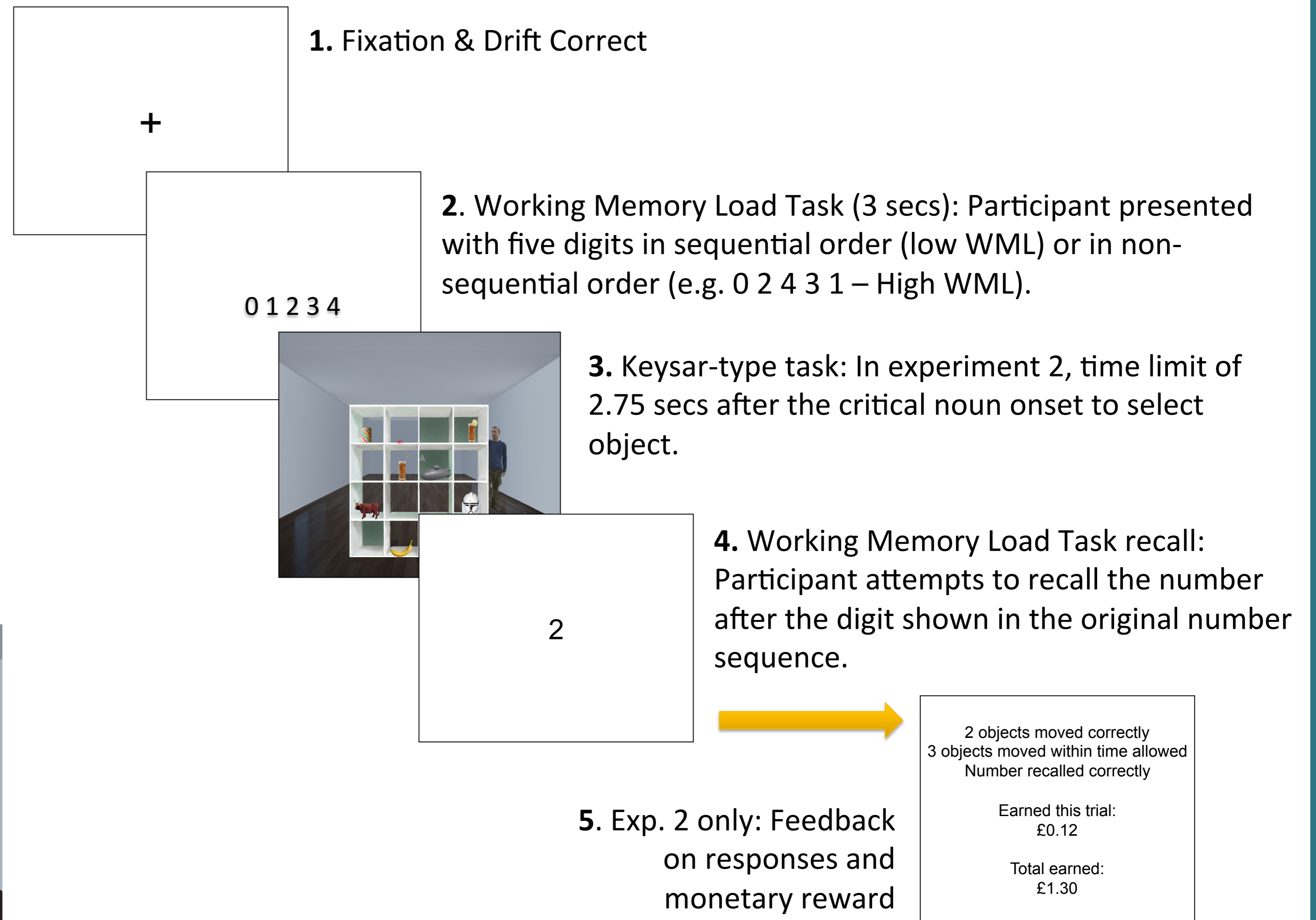
Across two experiments participants moved target objects (e.g. a glass with an umbrella in) around a grid based on instructions from an avatar (e.g. "Move the glass with the umbrella in up"). In Experiment 1 no reward was given for correct responses. In Experiment 2 participants received financial reward for quick and accurate responses, which required taking the avatar's perspective earlier.

Method

Keysar-type task



Procedure



Participants: University of Kent students: Exp. 1 N = 36; Exp. 2 N = 31; **Apparatus:** Eyelink 1000 eyetracker (1000Hz)

Materials: 12 x Listener Privileged trials, 12 x Shared Perspective trials, 12 x Speaker Privileged trials (randomised)

Measures: Target selection response times (RTs), and fixation bias log-ratio measure (Target/Distractor) = $\ln \left(\frac{P_{(\text{Fixations to Target}) + 1}}{P_{(\text{Fixations to Competitor}) + 1}} \right)$

Analyses: ANOVA (response times) & Growth Curve Analysis (time-course data): third-order orthogonal polynomials fit for time (linear, quadratic, and cubic).

Results

Experiment 1 (no urgency)

RTs: Significant effect of working memory load ($p < .01$, see Figure 1) – no interaction with perspective ($p = .75$).

Fixation time-course (see Figure 2):

Intercept Target Bias – Listener Privileged > Shared Perspective ($Est. = -.04, SE = .02, p < .05$)

Listener Privileged < Speaker Privileged ($Est. = .22, SE = .02, p < .001$)

Marginally significant working memory load effect in Shared perspective condition only ($Est. = -.04, SE = .02, p = .07$).

Polynomial fit – Significant cubic fit for wm load in Shared condition ($Est. = .24, SE = .05, p < .001$) with more pronounced shift to distractor object in high wm load condition.

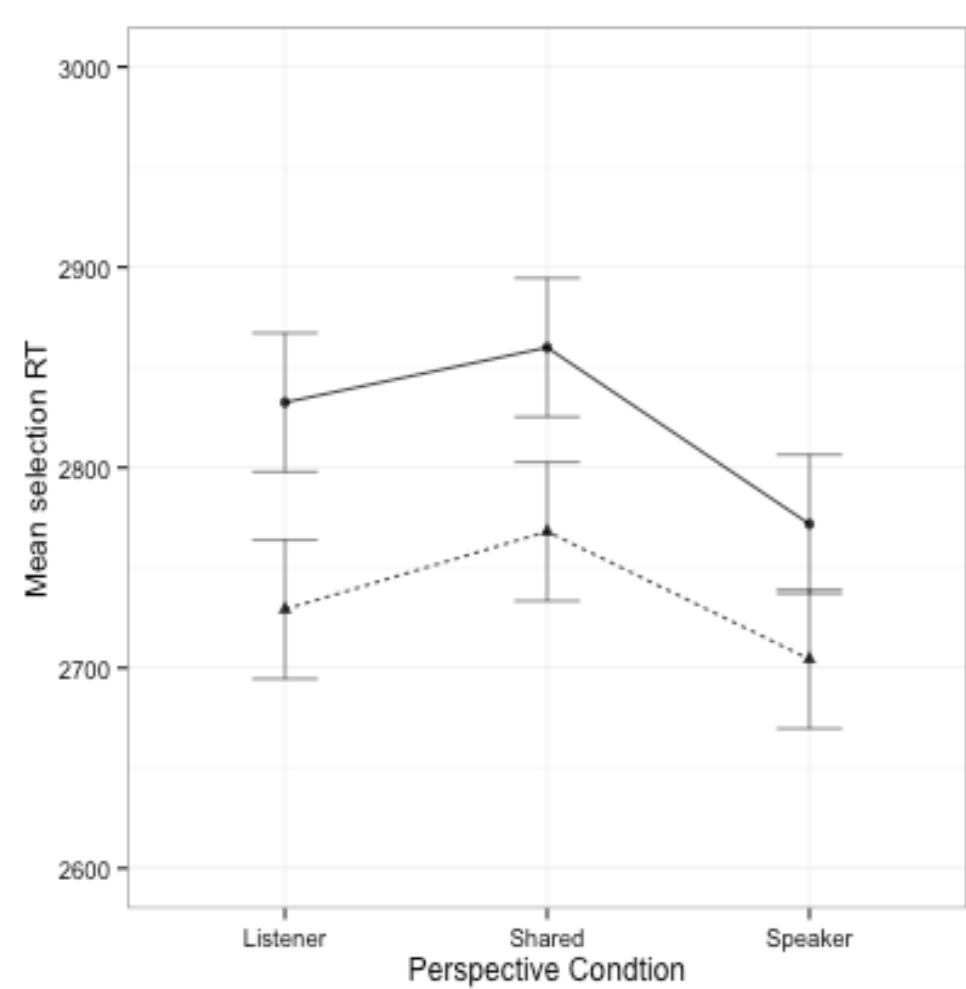


Figure 1. RTs to target selection Exp. 1

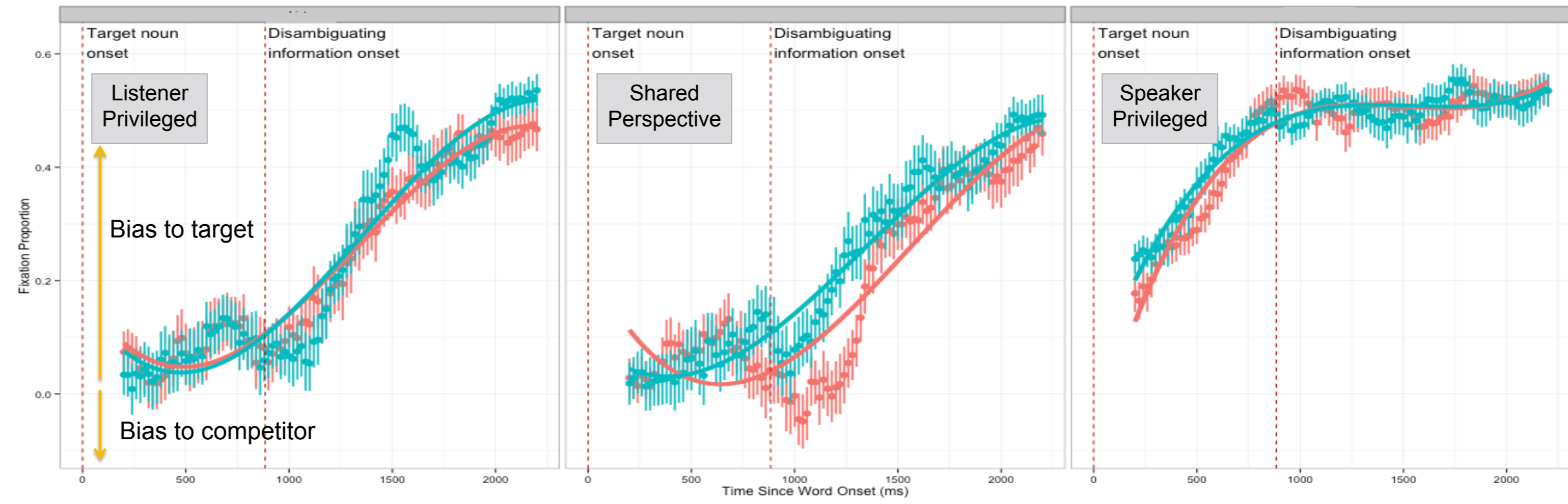


Figure 2. Fitted model (solid lines) and observed data for target fixation bias in Experiment 1 by perspective and WML conditions

Experiment 2 (urgency - reward)

RTs: Marginally significant interaction of perspective x WML - effect of working memory load in Listener Privileged condition ($p = .06$, see Figure 3).

Fixation time-course (see Figure 4):

Intercept Target Bias – Listener Privileged > Shared Perspective ($Est. = -.10, SE = .01, p < .001$)

Listener Privileged < Speaker Privileged ($Est. = .16, SE = .01, p < .001$)

Significant working memory load effect in Listener Privileged condition ($Est. = -.04, SE = .01, p < .001$).

Polynomial fit – For the Listener Privileged condition significantly greater cubic fit under low load than under high load ($Est. = -.45, SE = .05, p < .001$) – characterised by initial rise in fixations to target prior to disambiguating information (c. onset to 500ms) under low load which was not present under high load.

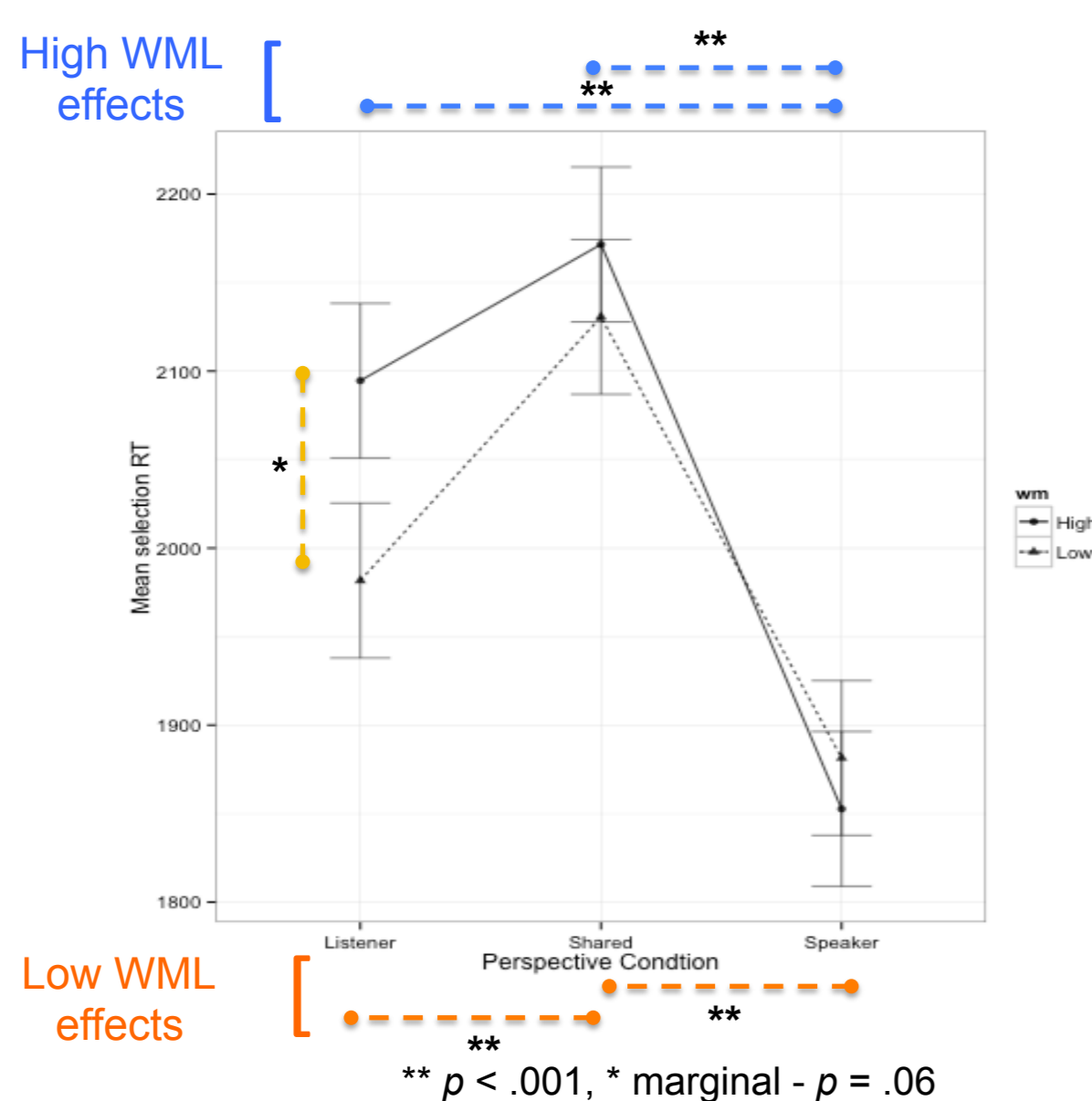


Figure 3. RTs to target selection Exp. 2

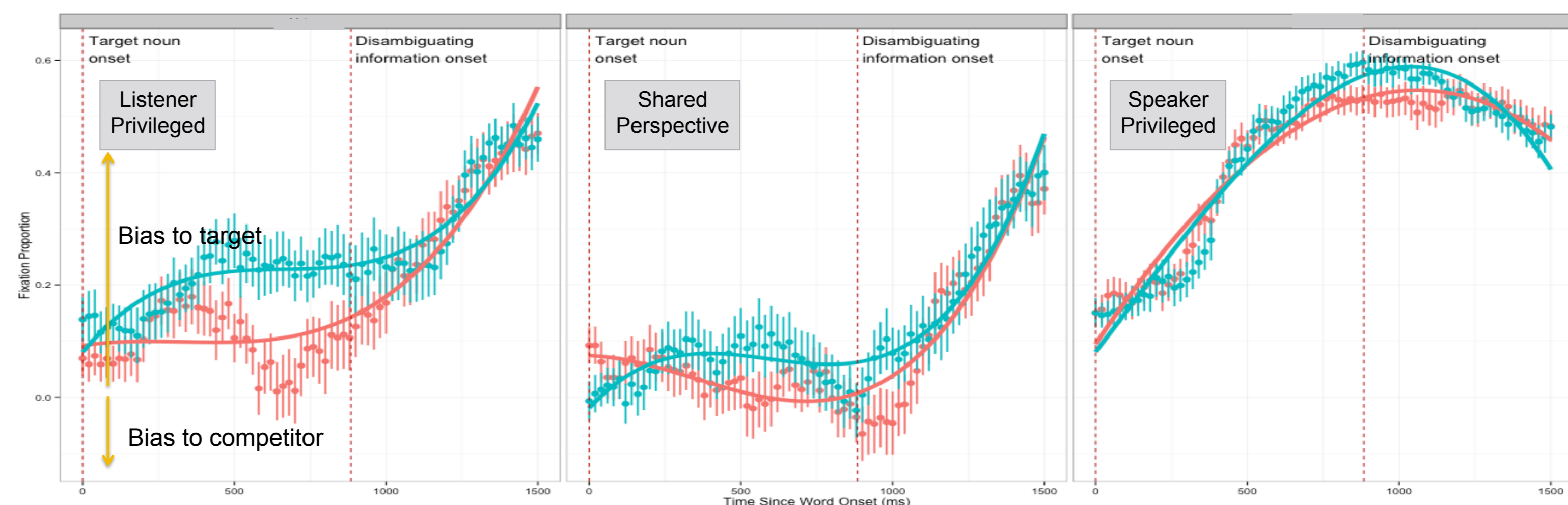


Figure 4. Fitted model (solid lines) and observed data for target fixation bias in Experiment 2 by perspective and WML conditions

Conclusions

These results show that, when there is no urgency, holding privileged knowledge about objects interferes with our ability to take another's perspective under both high and low working memory load. However, when there is some urgency and under low load conditions the ability to ignore distracting objects is improved. The detrimental effect shown in the high working memory load condition compared to the low working memory load condition in Experiment 2 indicates that successful perspective-taking in urgent situations is cognitively effortful.