

INTRODUCTION

Background:

- Previous studies have found large differences between adults and children in behavior and neural control networks during task switching performance [Church et al. 2016; Chevalier et al. 2010].

Objective:

- To test whether differences in eye gaze pattern may inform accuracy and response time differences in task switching performance for adults and children.
- To determine at roughly what age children become more adult-like in both task performance and eye gaze patterns

Approach:

- Eyelink 1000 Plus tracked participants' fixations on areas of interest during trials of a task switching computer game under two working demand conditions (within subject).

METHODS

Participants:

- 52 Adults (24 males, 28 females; M=22.08 years, 18-27 y.o.)
- 51 Children (28 males, 23 females; M=12.51 years, 8-16 y.o.)

Exclusion Criteria:

- <60% task accuracy on first level (2B2F)
- <200ms response time
- 3+ blinks in a 4000ms trial

Task:

- Three Interest Areas: Features, Choices, and Target.
- Participants responded which Choice matched the Target based on the indicated Feature.
- Three levels manipulating the number of features that can be cued (2 or 4) and response choices presented (2 or 4).
- Each level was a mixture of task repetition/switch and response congruency/incongruency to the target.

Analysis:

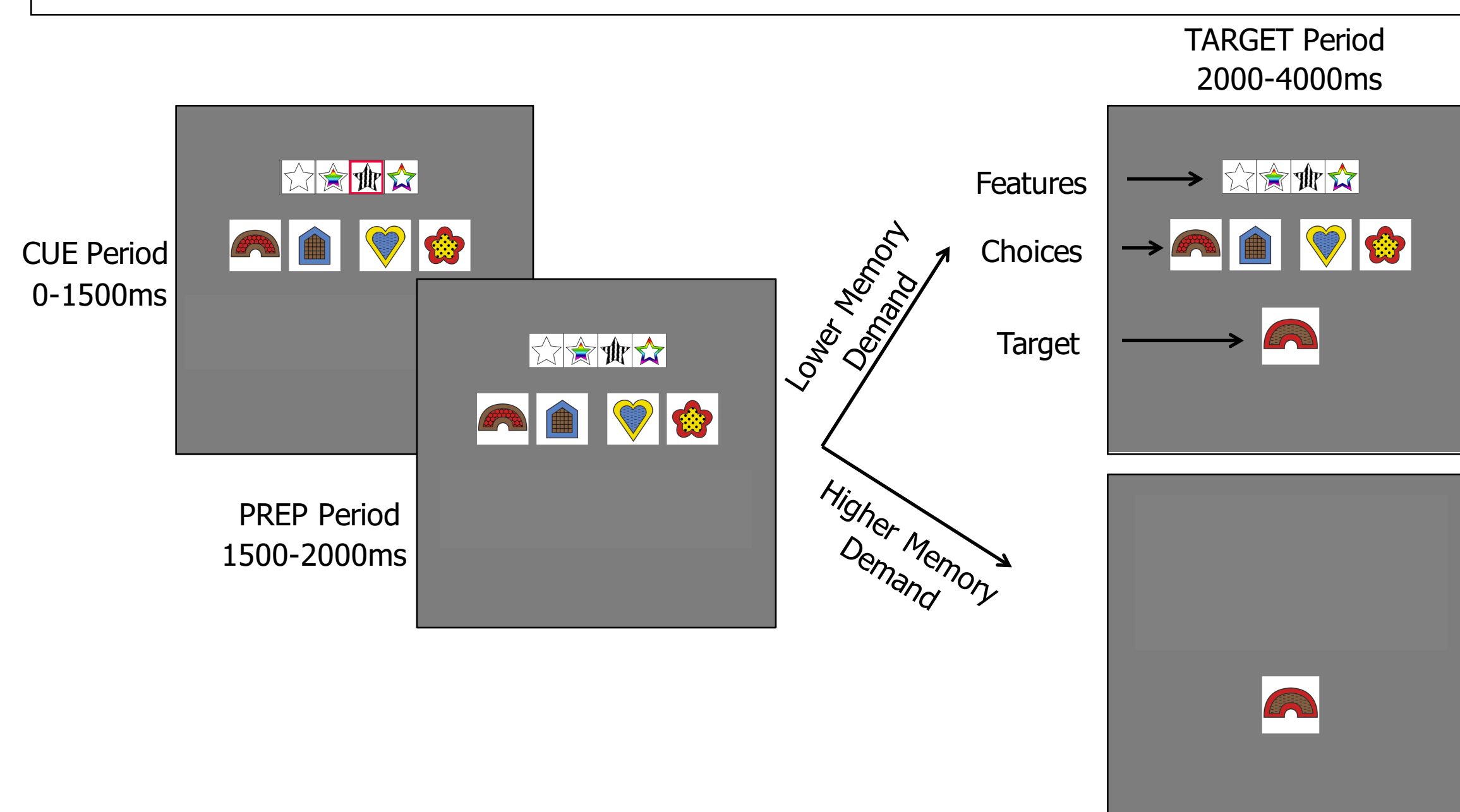
- Linear mixed effect models of fixation times on Interest Areas (Features, Choices and Target) during the Cue Period (0-1500msec), Prep Period (1500-2000msec) and the Target Period (2000-4000msec).

Study 1: Lower Working Memory Demand

- The feature bar and the response choices remained on the screen when the target appeared in the last 2000msec of the trial.

Study 2: Higher Working Memory Demand

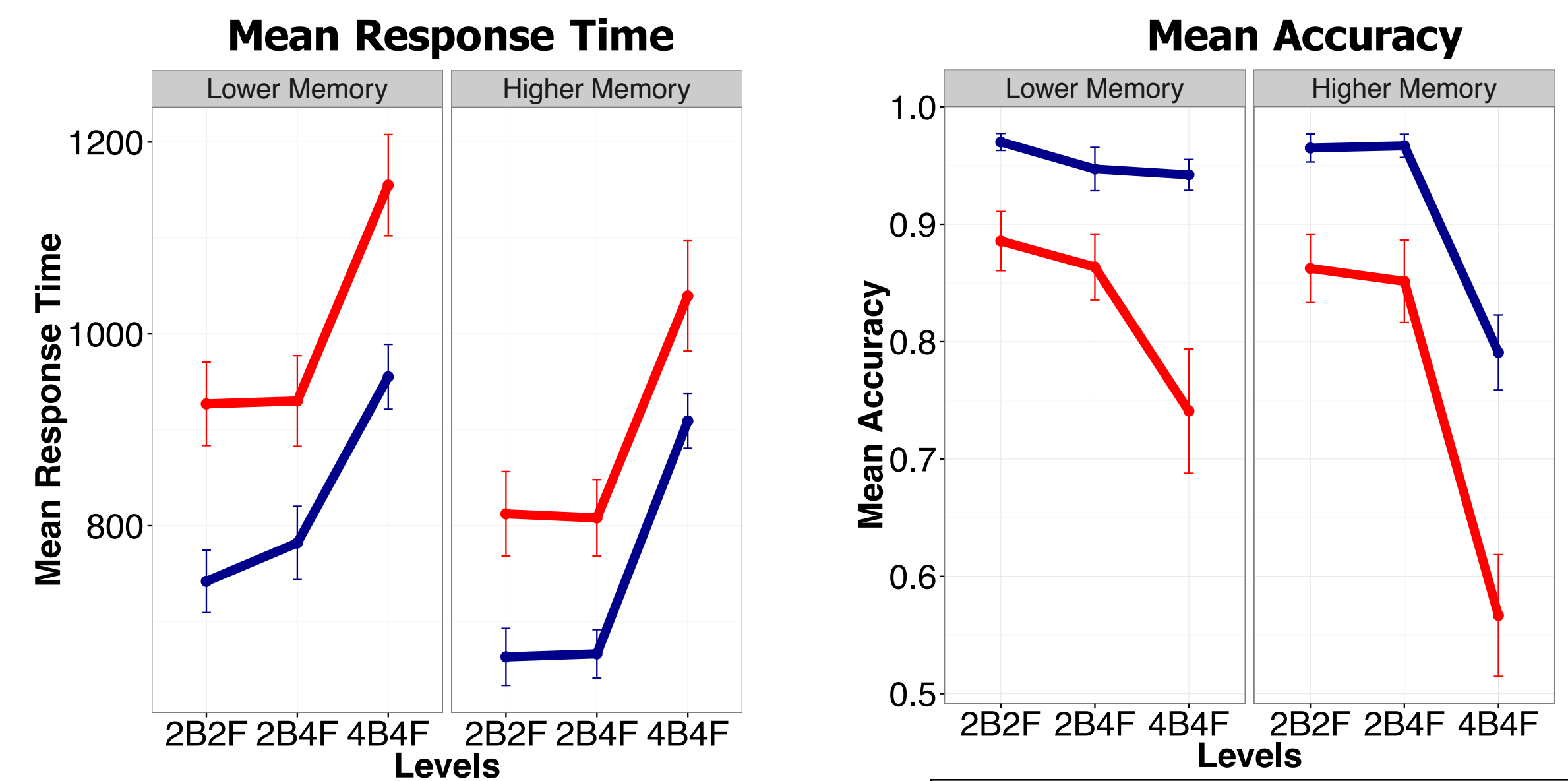
- The target appeared alone on the screen for the last 2000msec to increase working memory demand



The cued feature, indicated by a red box, was presented during the first 1500ms. There was a 500ms delay period between cue and target presentation. A target then appeared in the last 2000ms of a trial in which participants are asked to respond via a button box.

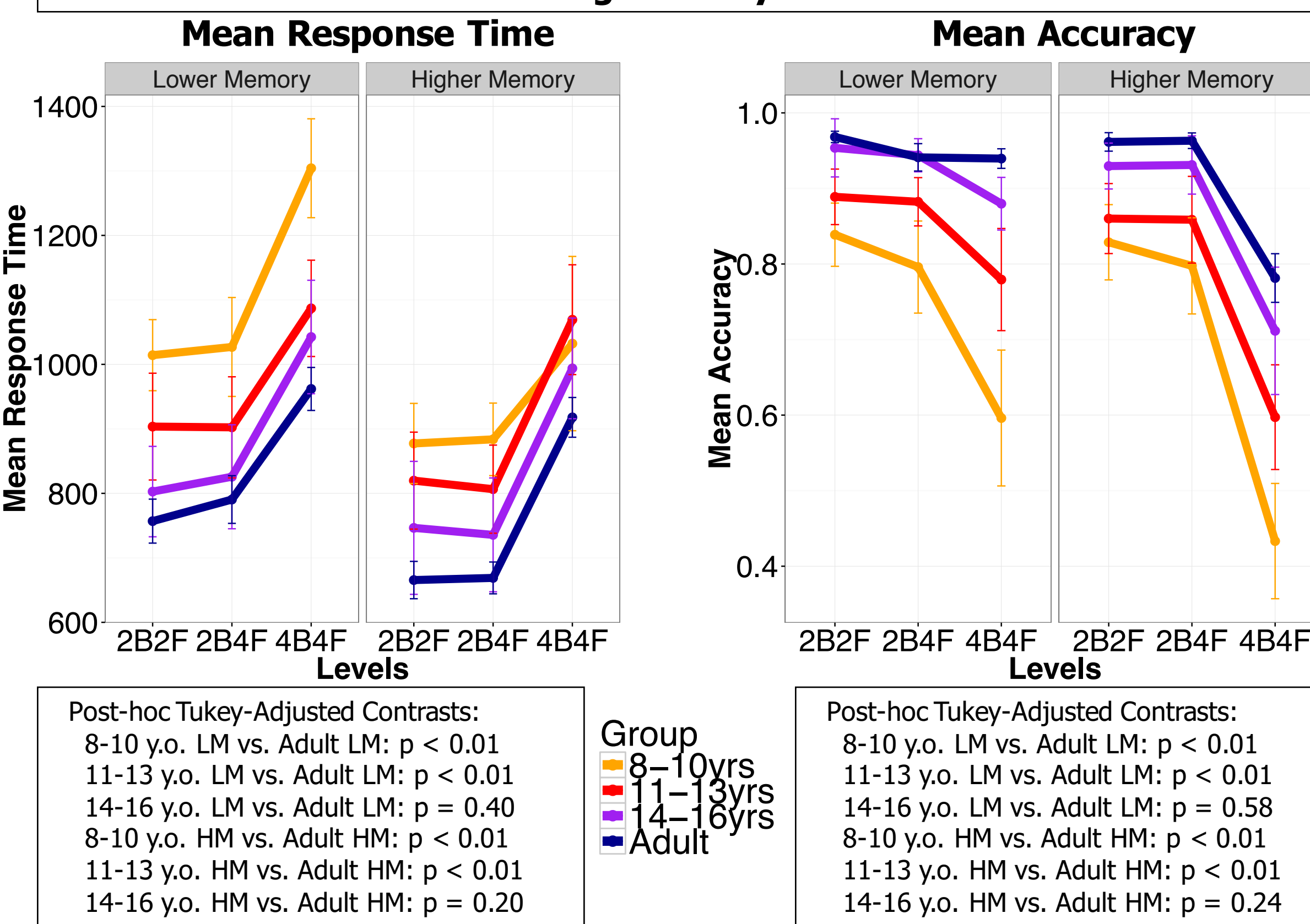
GROUP ACCURACY AND RESPONSE TIME

Children were slower than adults, and their accuracy was more affected by increasing response number and working memory demand



Significant effect of Group for both LM & HM ($p < .01$). Significant interaction effect of Group x Game (LM, HM) ($p < .05$). Significant main effect of Group for both games ($p < .01$). Significant interaction effect of Group x Game ($p < .05$) and Group x Level ($p < .01$).

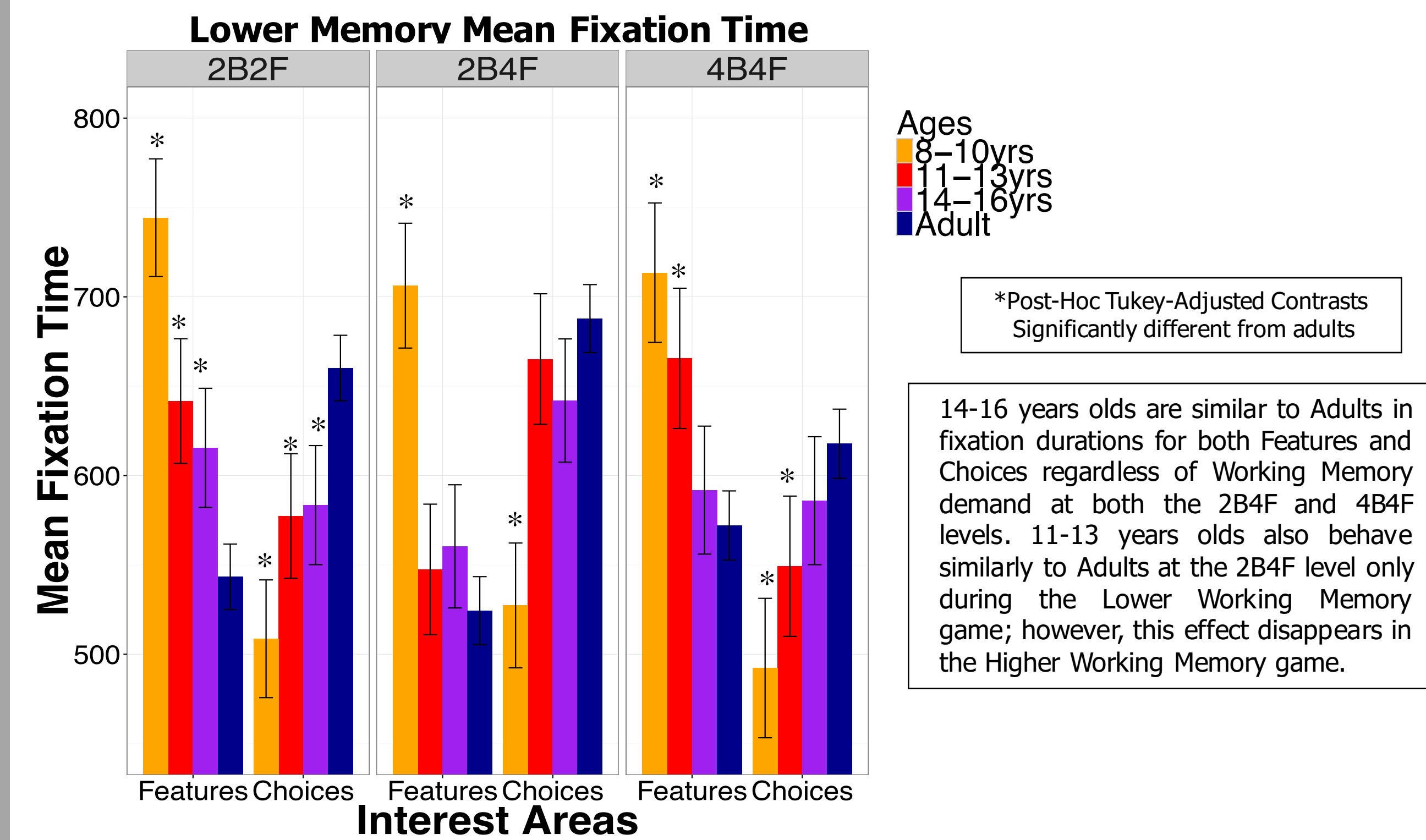
14-16 years olds were reaching Adult levels of performance regardless of working memory demand



Post-hoc Tukey-Adjusted Contrasts:
 8-10 y.o. LM vs. Adult LM: $p < .01$
 11-13 y.o. LM vs. Adult LM: $p < .01$
 14-16 y.o. LM vs. Adult LM: $p = .40$
 8-10 y.o. HM vs. Adult HM: $p < .01$
 11-13 y.o. HM vs. Adult HM: $p < .01$
 14-16 y.o. HM vs. Adult HM: $p = .020$

FIXATION RESULTS: CUE PERIOD (0-1500 msec)

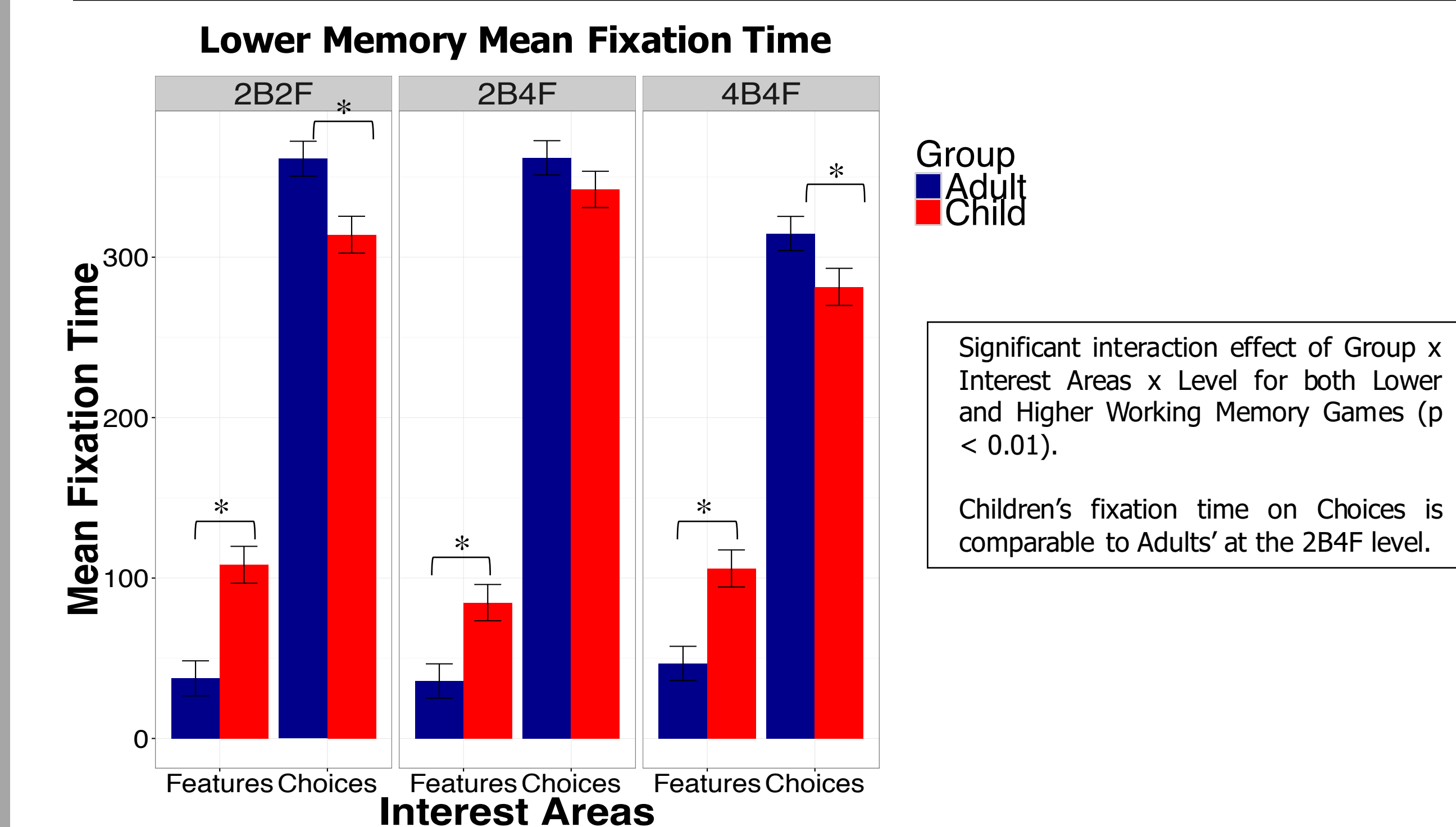
Children become more similar to Adults in their fixation durations and locations over the examined age range



*Post-Hoc Tukey-Adjusted Contrasts Significantly different from adults
 14-16 years olds are similar to Adults in fixation durations for both Features and Choices regardless of Working Memory demand at both the 2B4F and 4B4F levels. 11-13 years olds also behave similarly to Adults at the 2B4F level only during the Lower Working Memory game; however, this effect disappears in the Higher Working Memory game.

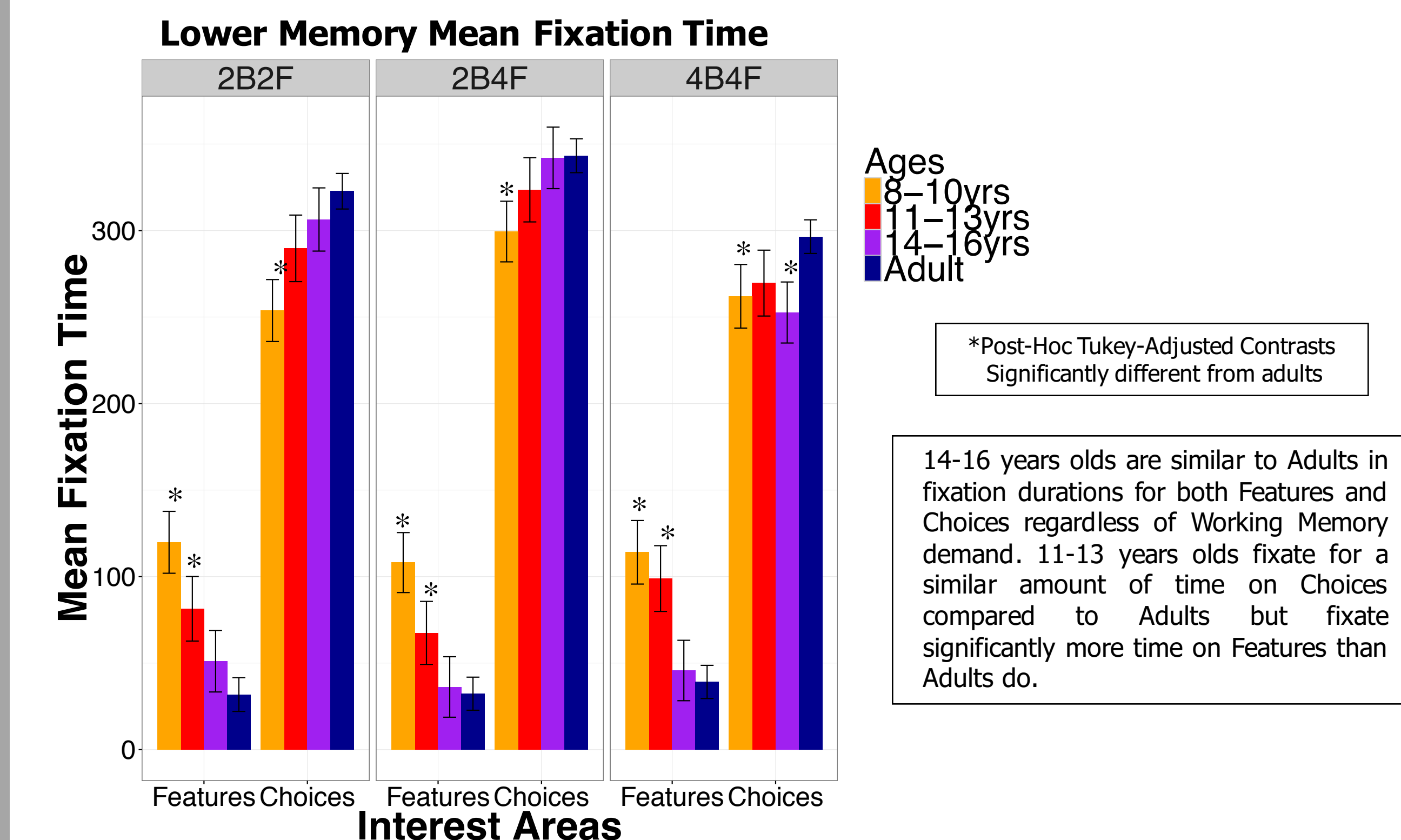
FIXATION RESULTS: PREP PERIOD (1500-2000ms)

Children's fixation times are comparable to Adults during the 2 Button 4 Feature level. Both Children and Adults fixate on Choices more than Rules.



Significant interaction effect of Group x Interest Areas x Level for both Lower and Higher Working Memory Games ($p < .01$). Children's fixation time on Choices is comparable to Adults' at the 2B4F level.

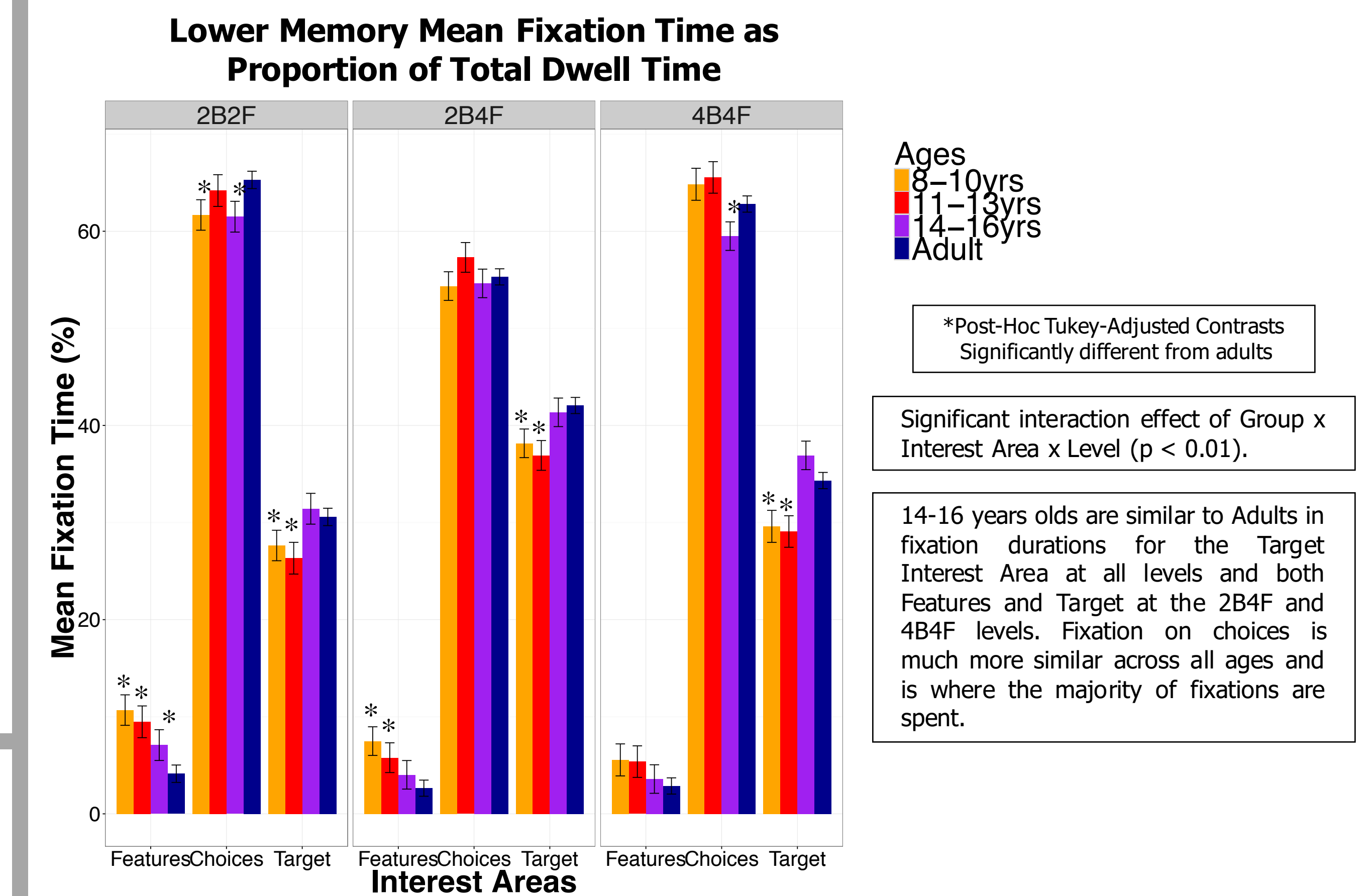
14-16 years olds are comparable to Adults in fixation time for Rules and Choices.



*Post-Hoc Tukey-Adjusted Contrasts Significantly different from adults
 14-16 years olds are similar to Adults in fixation durations for both Features and Choices regardless of Working Memory demand. 11-13 years olds fixate for a similar amount of time on Choices compared to Adults but fixate significantly more time on Features than Adults do.

FIXATION RESULTS: TARGET PERIOD (2000 msec-Response)

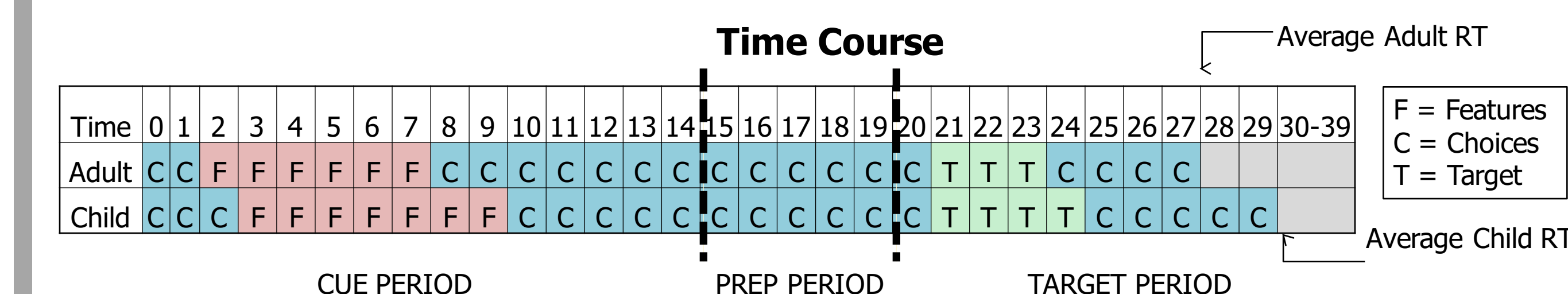
14-16 years olds were similar to Adults in Target fixation duration.



*Post-Hoc Tukey-Adjusted Contrasts Significantly different from adults
 Significant interaction effect of Group x Interest Area x Level ($p < .01$).
 14-16 years olds are similar to Adults in fixation durations for the Target Interest Area at all levels and both Features and Target at the 2B4F and 4B4F levels. Fixation on choices is much more similar across all ages and is where the majority of fixations are spent.

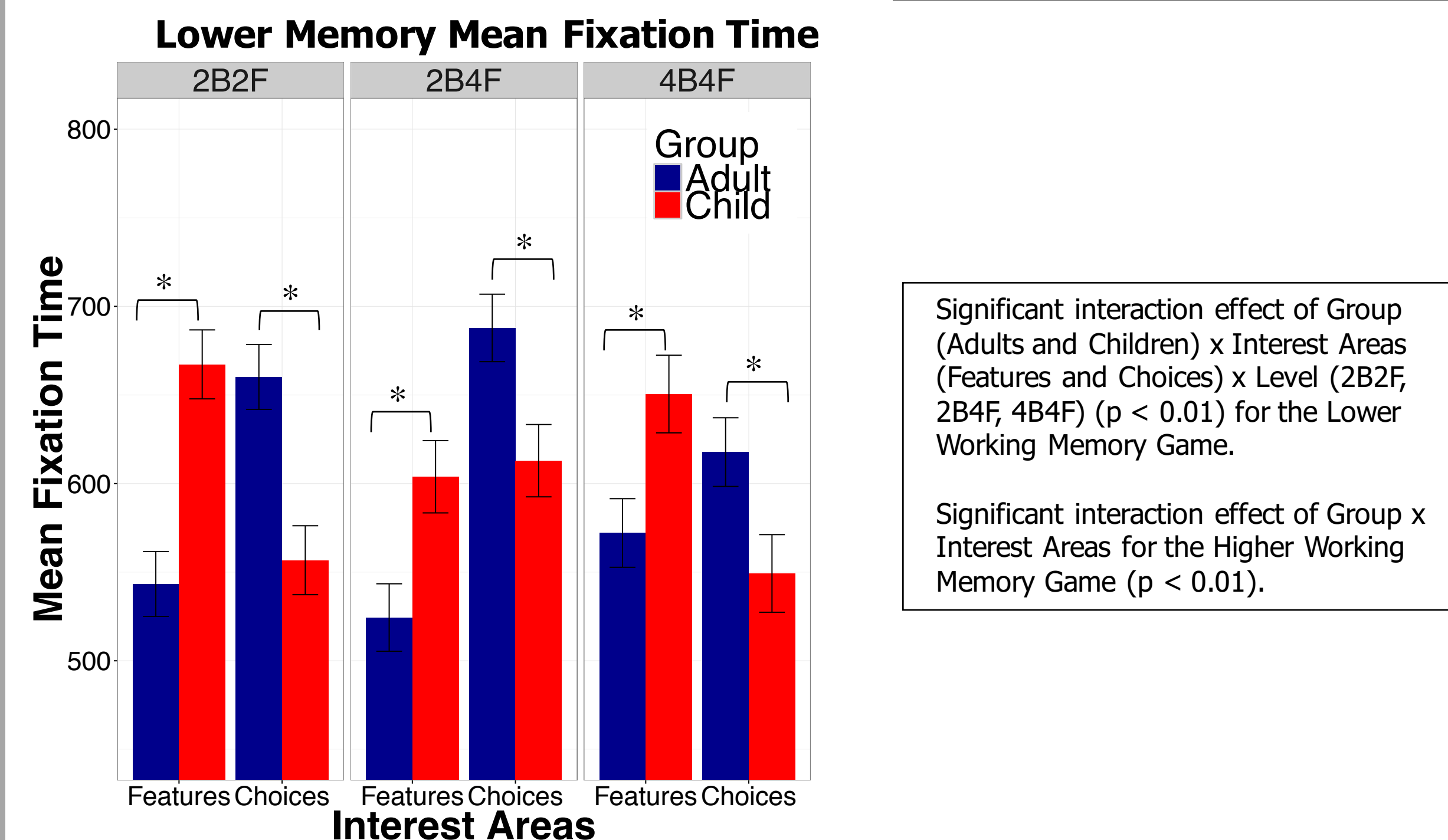
TIME COURSE

- Employing a "Winner-Take-All" strategy, we divided the 4000msec trial time course into 100msec bins and examined which Interest Area participants fixated on the most for correct-only trials.
- Children appeared to be delayed in cued Feature processing leading to subsequent delays in Choice processing and longer response time.



FIXATION RESULTS: CUE PERIOD (0-1500 msec)

Children fixated longer on the cued features compared to Adults for both Lower and Higher Working Memory Games.



Significant interaction effect of Group (Adults and Children) x Interest Areas (Features and Choices) x Level (2B2F, 2B4F, 4B4F) ($p < .01$) for the Lower Working Memory Game.
 Significant interaction effect of Group x Interest Areas for the Higher Working Memory Game ($p < .01$).

CONCLUSIONS & NEXT STEPS

- Children spent more time than adults fixating on the cued feature bar during the Cue Period and Prep Period.
- 14-16 years olds had more adult-like performance and eye gaze patterns.
- Lexical visual cues [Church et al. 2016] and symbolic visual cues reveal strong developmental preparatory effects in cued task switching. Our next exploration: multimodal cueing.

References

Church JA, Bunge SA, Petersen SE, Schlaggar BL. Preparatory engagement of cognitive control networks increases late in childhood. *Cerebral Cortex*. 2016. doi:10.1093/cercor/bhw046.
 Chevalier N, Blaye A, Dufau S, Lucenet J. What visual information do children and adults consider while switching between tasks? Eye-tracking investigation of cognitive flexibility development. *Developmental Psychology*. 2010;46(4):955-72. doi: 10.1037/a0019674.