

Potential biomarker for ASD: Reduced pupil responses to repeated multisensory stimuli in young children with autism

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Background

A failure to habituate to multi-sensory stimuli may underlie sensory hypersensitivities across disorders, e.g., Autism Spectrum Disorder (ASD); differences in sensory processing and habituation may be detectable early on and can serve as a biomarker for ASD¹.

Objectives

First, to investigate whether pupil responses can serve as a biomarker for multi-sensory processing and habituation. Second, to gain a mechanistic understanding of pupil responses and habituation thereof in neurotypical adults and children.

Sample & Design

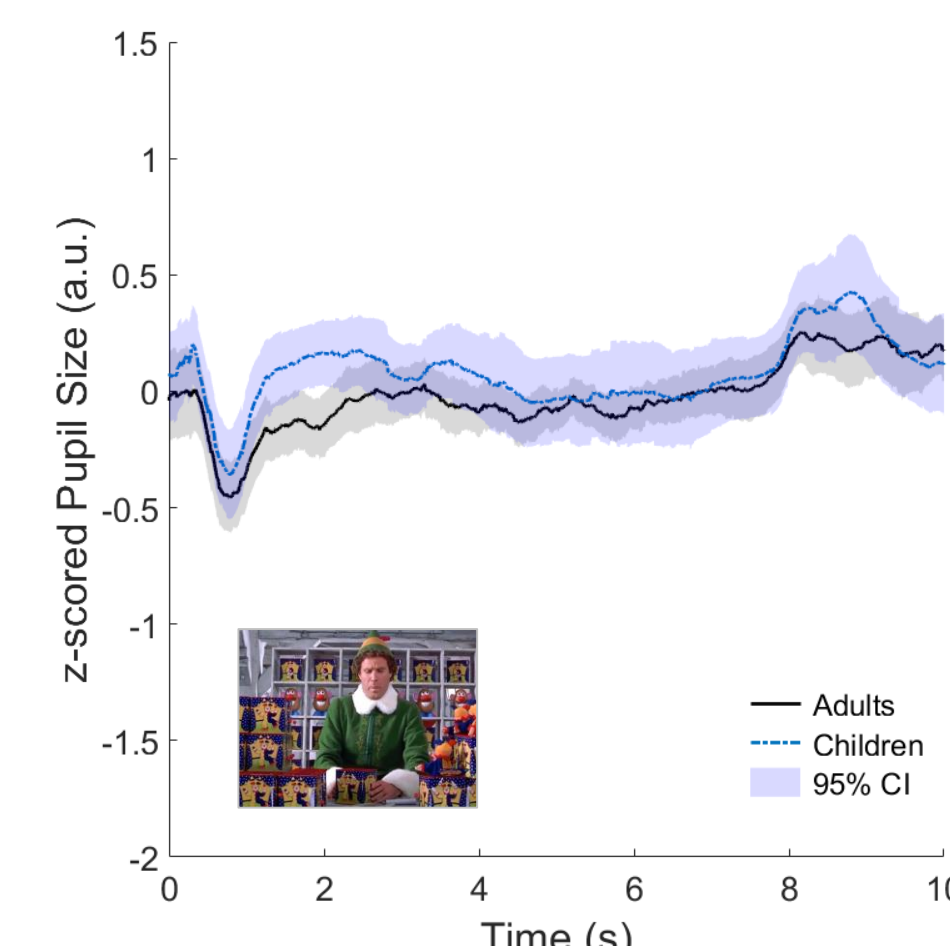
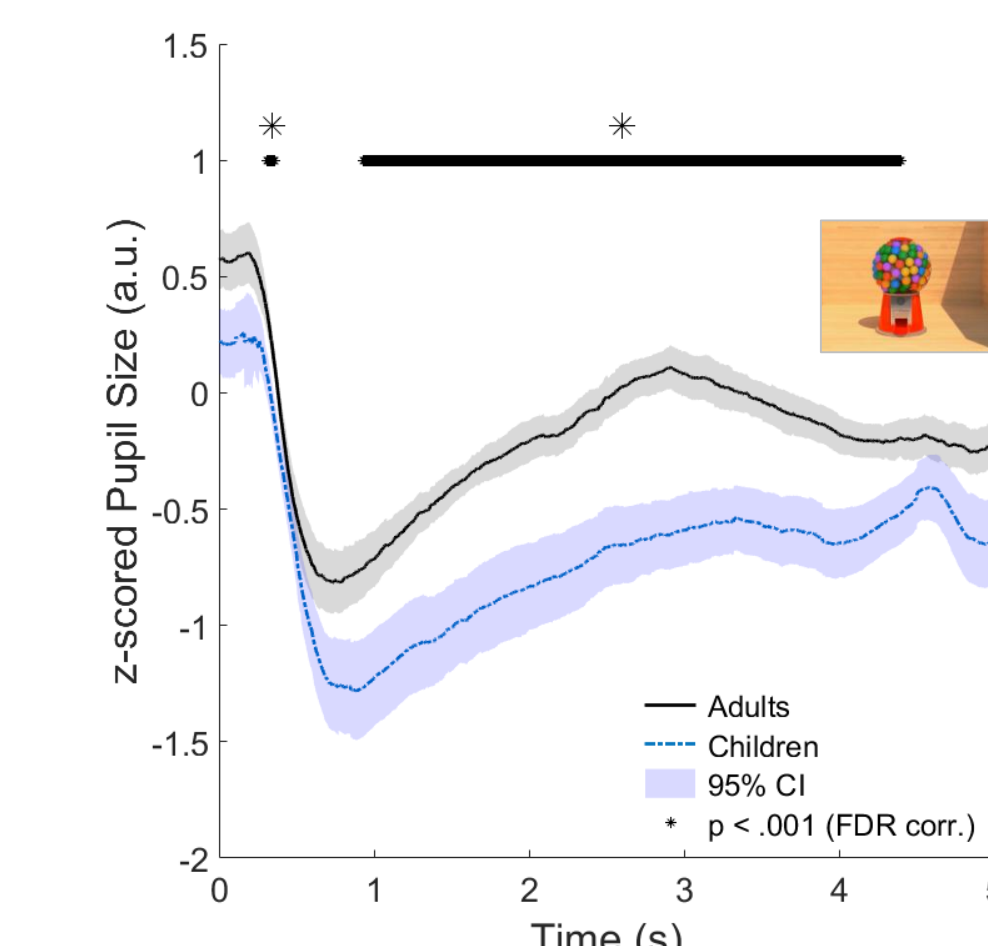
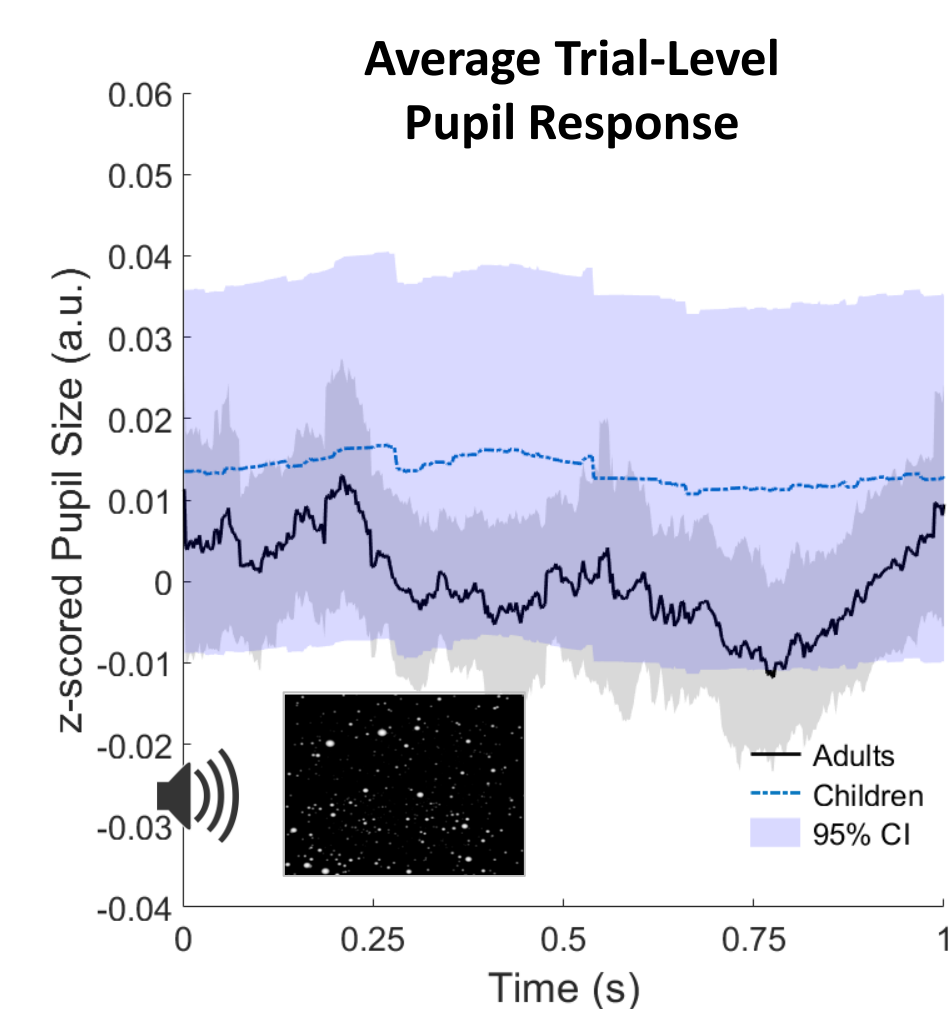
Participants: 20 adults, 21 neurotypical children ($M_{age} = 3.92$ yrs, $SD = 1.2$), 5 ASD children ($M_{age} = 4.17$ yrs, $SD = 1.01$)

Condition	Stimulus	Repetitions
Beeps	Optic flow field + beep/900ms	300 beeps (no ITI)
Bubblegum	5s animated gumball machine	50 trials (1-4s ITI)
Elf	10s jack-in-the-box movie clip	25 trials (2-8s ITI)

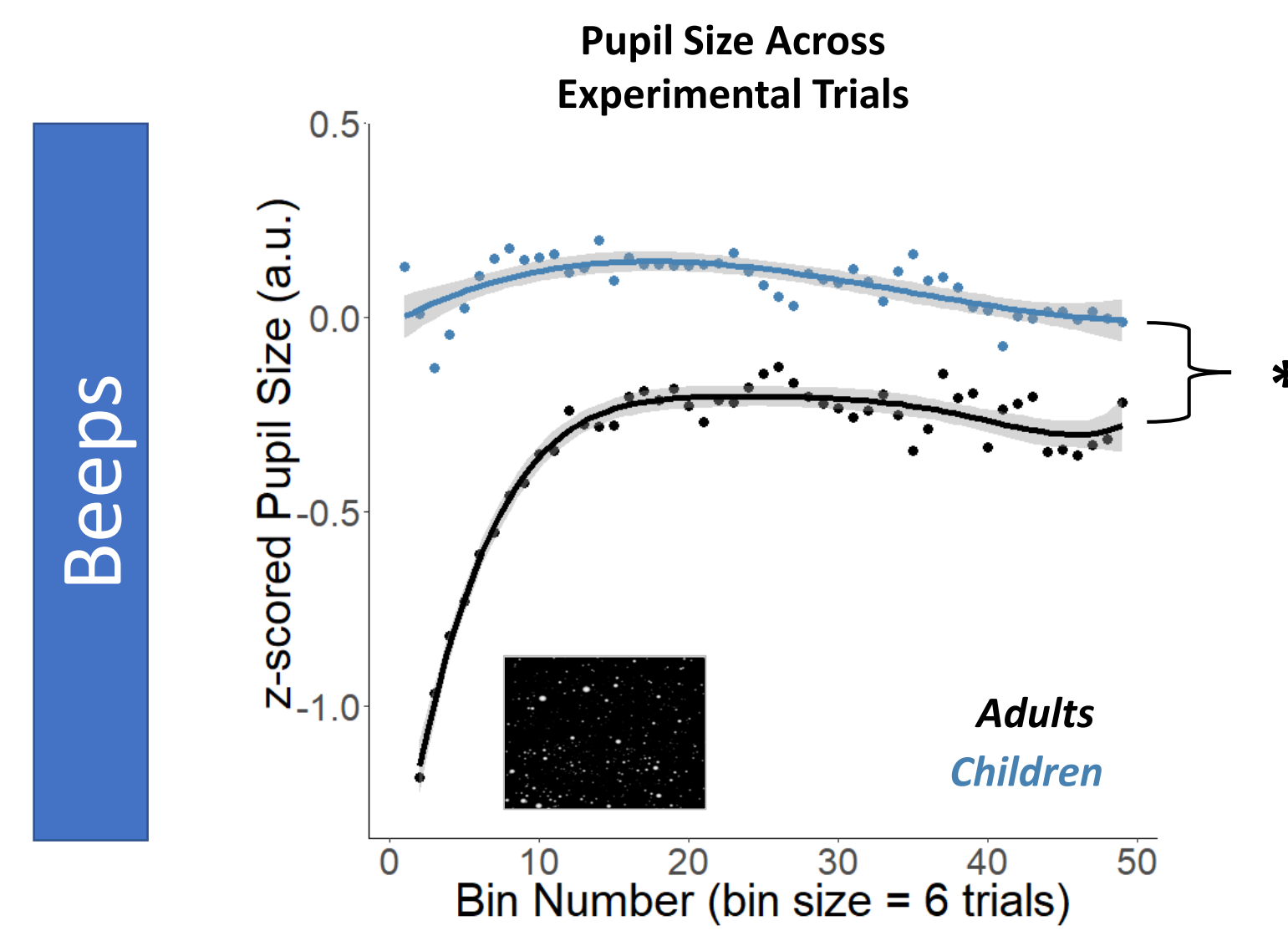
Data were collected via an EyeLink 1000 at 500Hz and preprocessed using the PsPM toolbox^{2,3}.

Pupil responses of neurotypical children and adults differ for higher complexity multi-sensory stimuli.

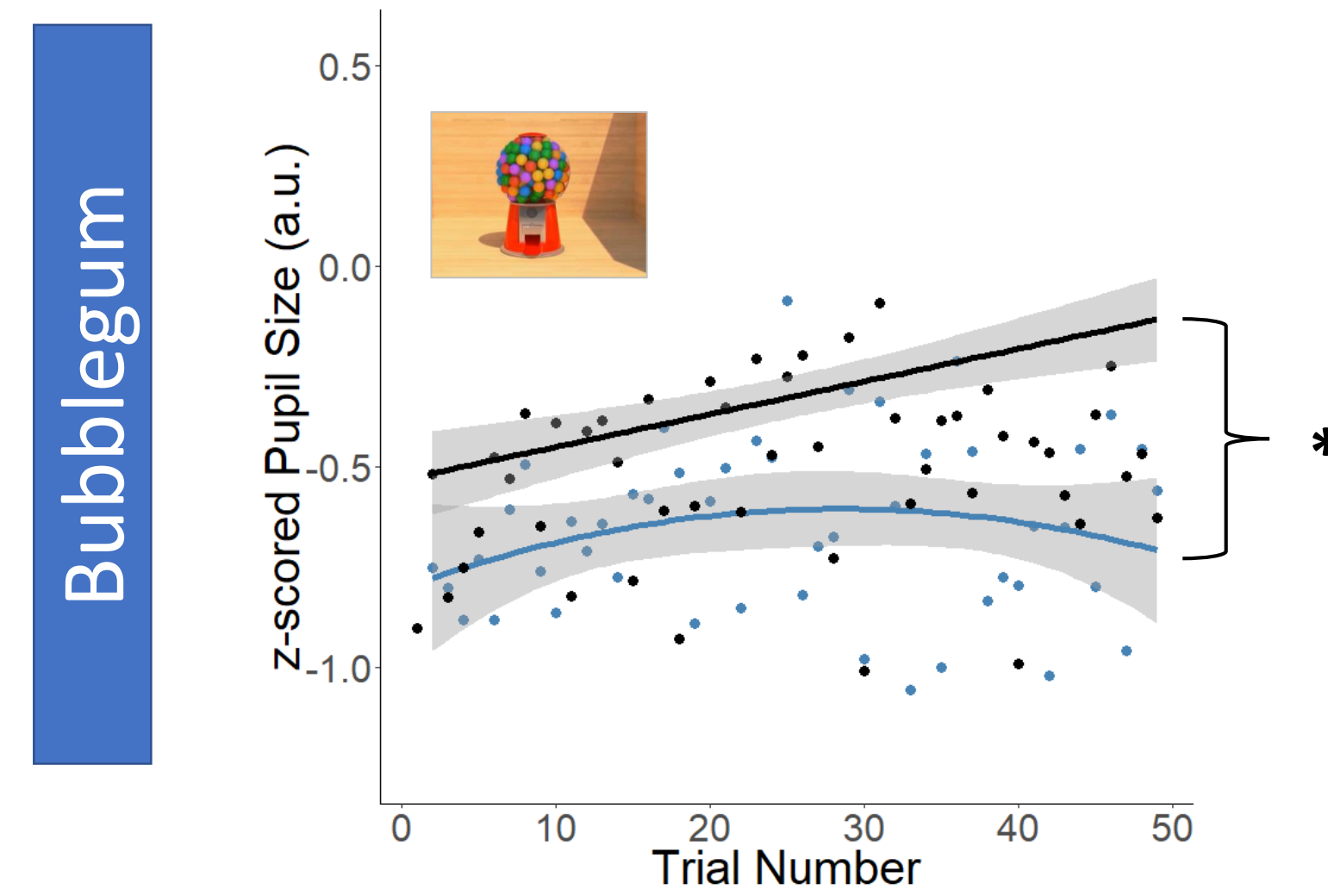
No group differences in pupil size evident at the lowest stimulus complexity, but emerge at moderate levels. Note that Beeps data are displayed on a different axis.



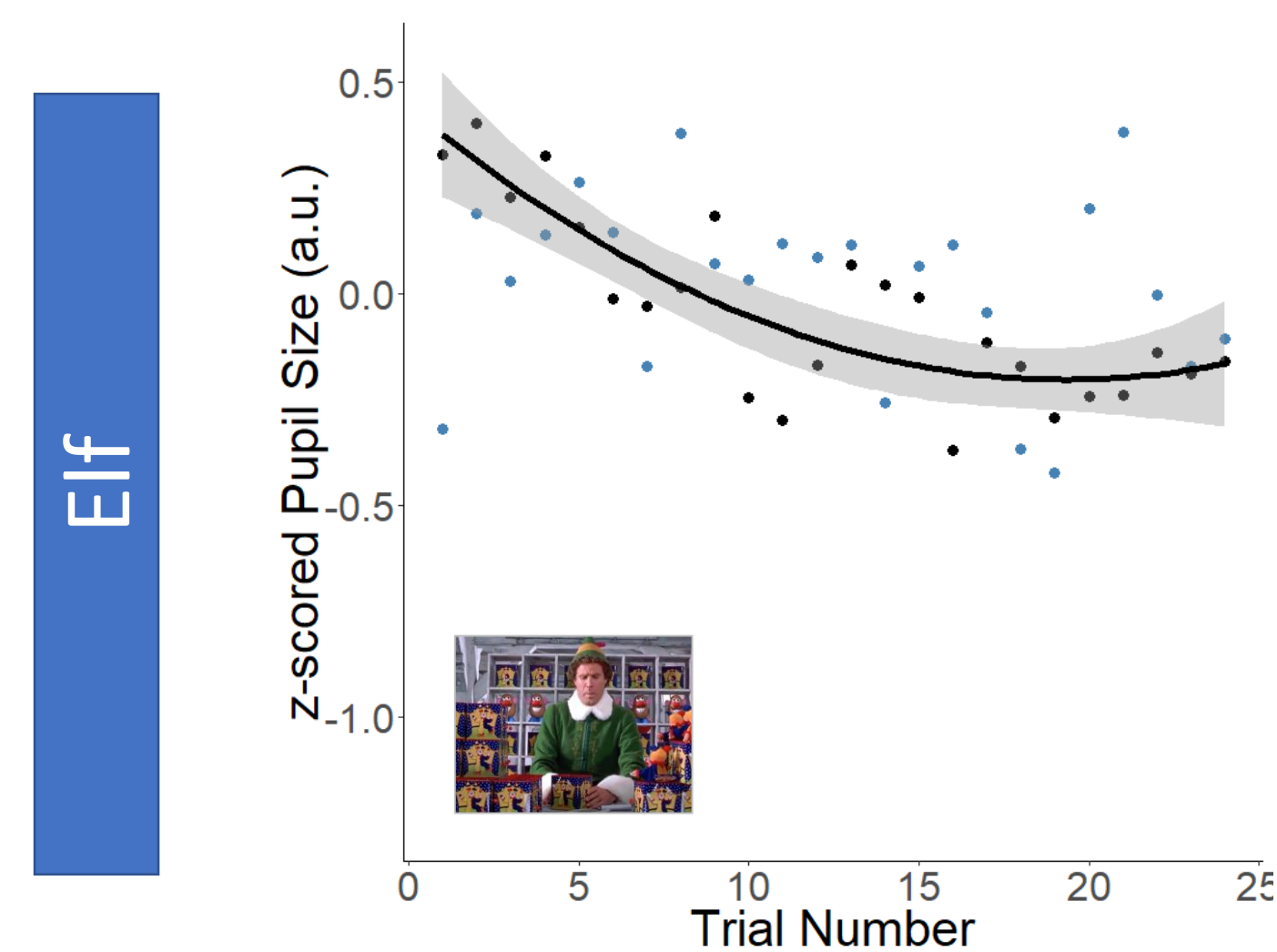
Habituation of pupil responses: Repetition based changes in pupil responses differ between adults and children.



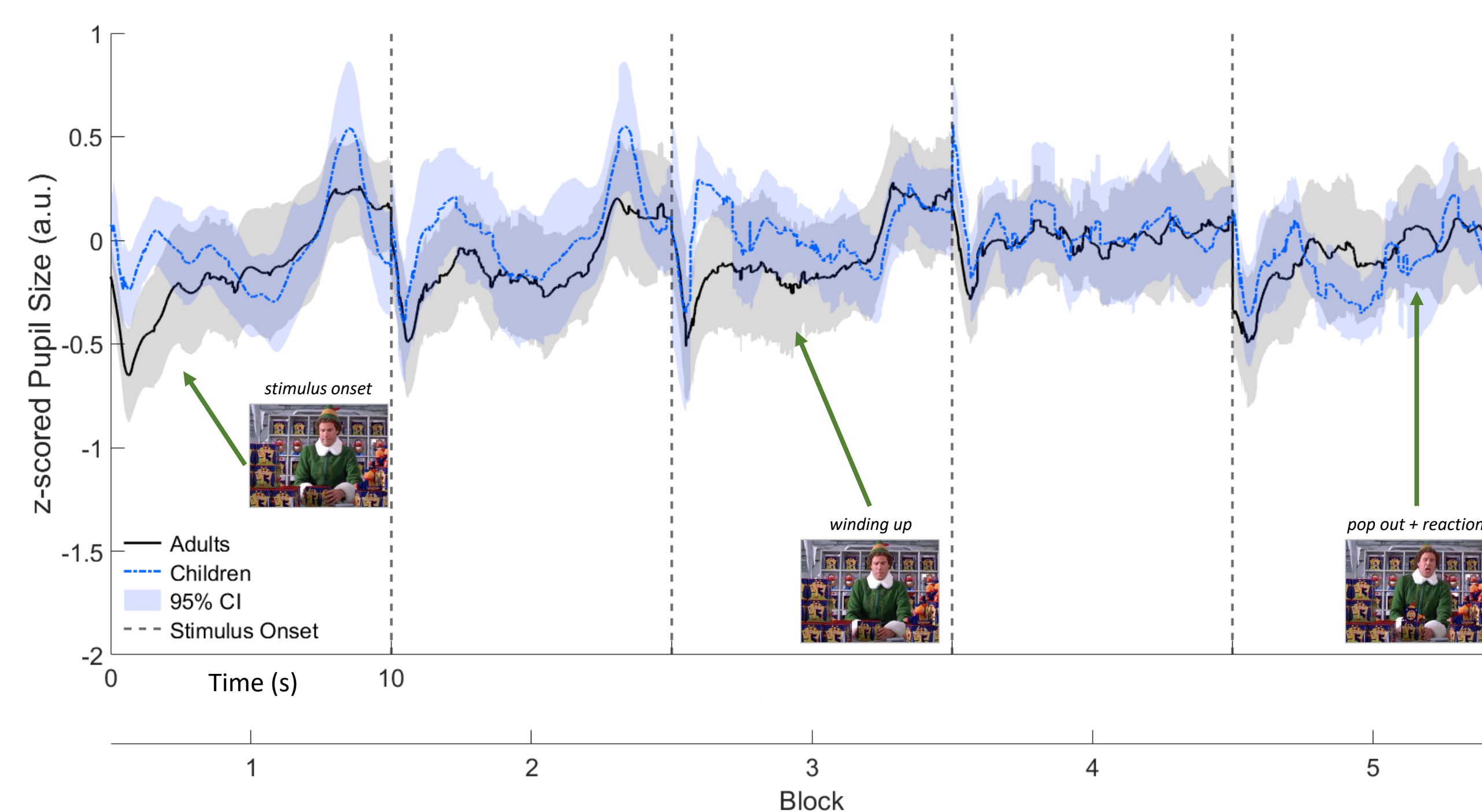
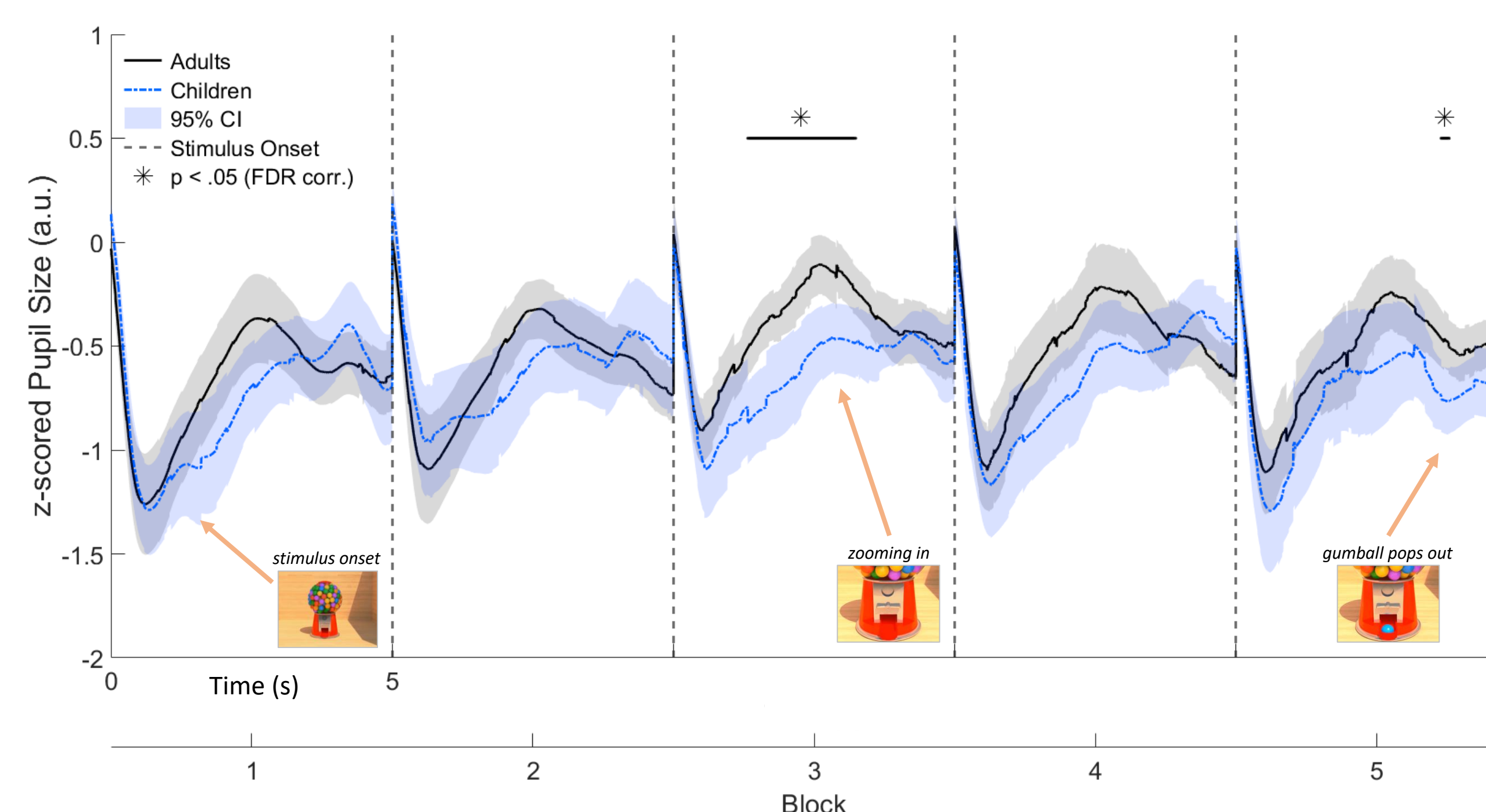
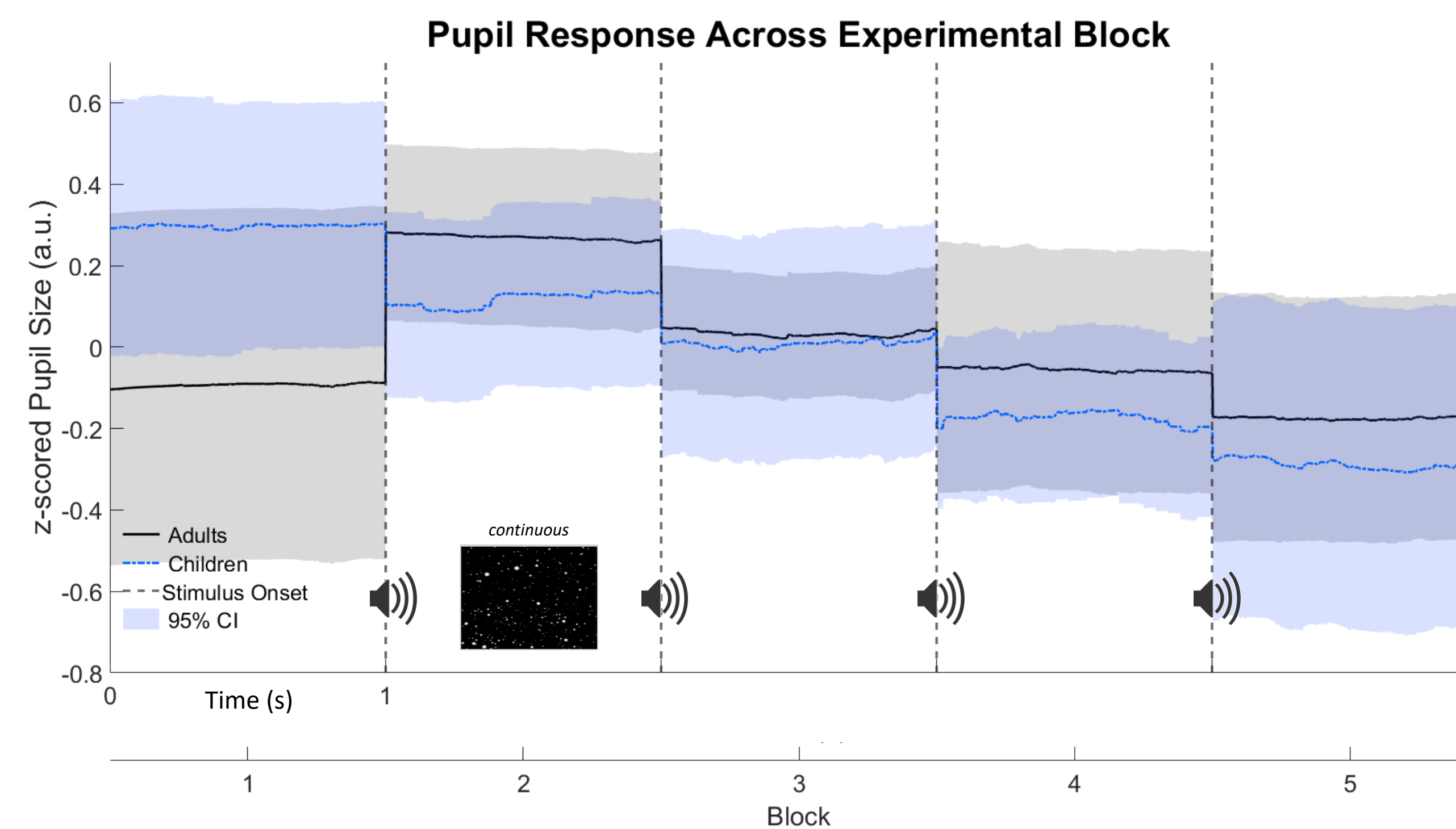
Significant difference in pupil responses in blocks (60 trials, right) of trial repetitions across experimental task to the low-complexity condition; children have greater pupil sizes and habituate slower than adults.



Significant difference in pupil responses in blocks (10 trials, right) of trial repetitions across experimental task to the more complex cartoon condition; children have smaller pupil sizes and habituate faster.

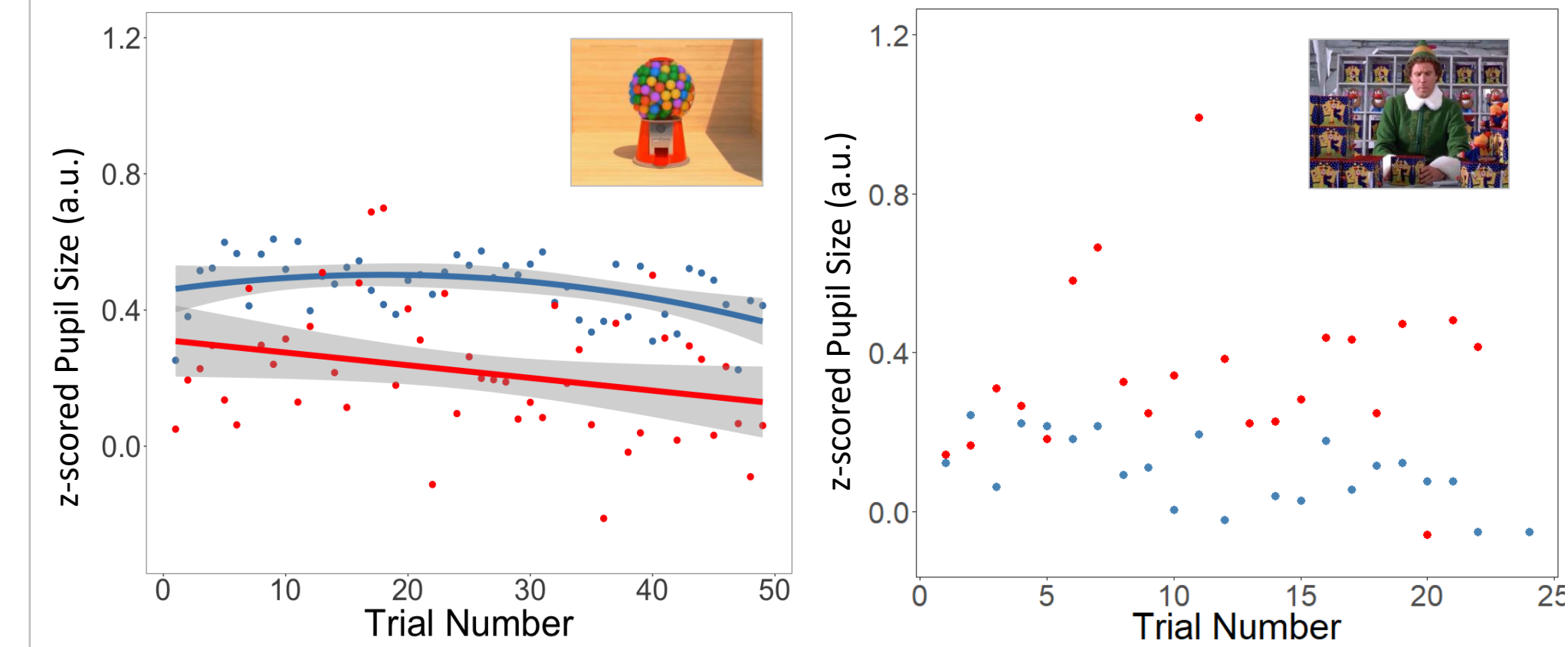
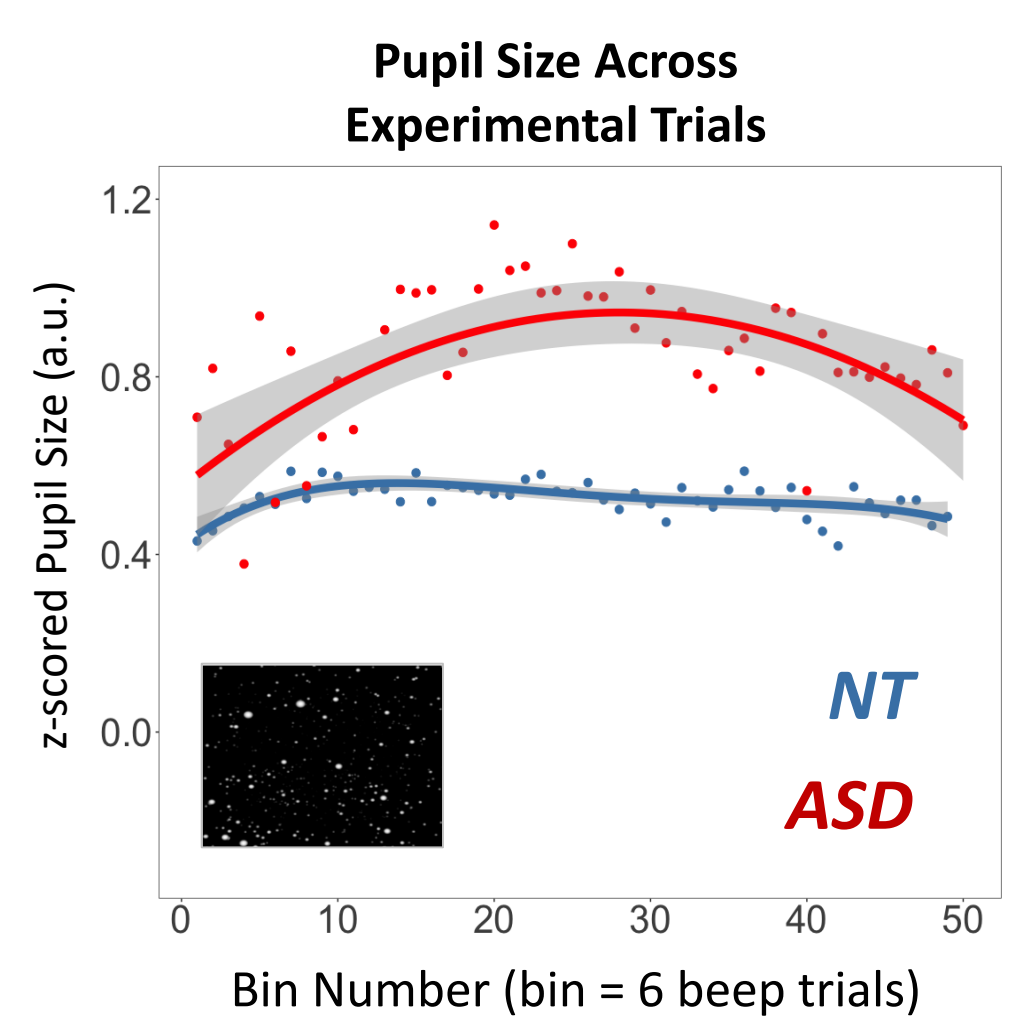


Significant difference in pupil responses in blocks (5 trials, right) of trial repetitions across experimental task to the high complexity, naturalistic condition; children have greater pupil sizes and do not show significant habituation.



Average event-related pupil response across stimulus complexities differs in neurotypical children and children with ASD.

ASD children exhibited larger pupil sizes and were slower to habituate than NT counterparts in the low-complexity condition; the opposite was true in the more complex cartoon condition. No habituation was found for either child group at the highest complexity level.



Discussion

Children and adults show structurally similar pupillary responses to multisensory stimuli. There are however **significant differences in the structure and speed of habituation**, indicating developmental changes in habituation.

Preliminary results in the ASD sample show that **children with ASD show less complex habituation profiles** in lower complexity conditions.

Next Steps

Characterize individual and group profiles of pupil responses via computational modeling in neurotypical individuals and in a larger sample of children with ASD.

Investigate whether these habituation profiles can predict ASD diagnosis and sensory profiles across diagnostic groups in young children.

1 Sinha, P., et al. (2014). Autism as a disorder of prediction. *Proceedings of the National Academy of Sciences*, 111(42).
 2 Bach, D. R., et al. (2018). Psychophysiological modeling: Current state and future directions. *Psychophysiology*, 55(11).
 3 Kret, M. E and Sjak-Shie, E. E. (2018) Preprocessing pupil size data: Guidelines and code. *Behavior research methods*, 51(3).