Proof of concept of a digital cognitive assessment tool, DEvelopmental assessment on an E-Platform (DEEP), for preschool children
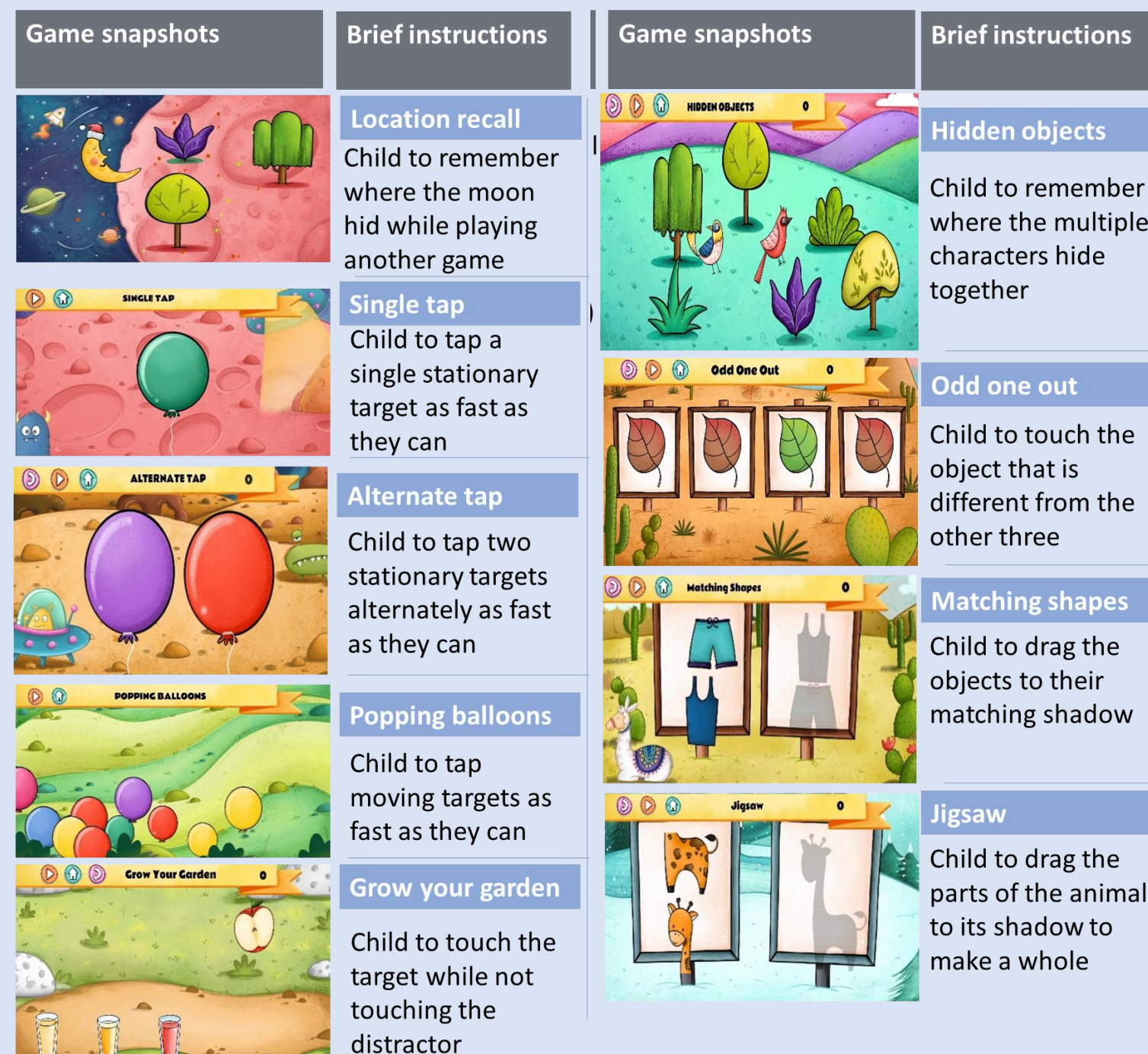
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Introduction

At least 250 million children in low- and middle-income countries (LMICs) are failing to reach their developmental potential due to multiple adversities experienced during early life. This is in part due to the lack of scalable cognitive assessment tools for preschool children to enable identification of children at-risk of sub-optimal development. There is an urgent need to fill this 'detection gap' so that we can support the timely referral of these children into effective early interventions.

To this end, we provide the proof-of-concept of a tablet-based tool, Developmental Assessment on an E-Platform (DEEP), comprising gamified neuropsychological tasks for cognitive assessment woven into a first person narrative.

Game snapshots	Brief instructions	Game snapshots	Brief instructions
	Location recall Child to remember where the moon hid while playing another game		**Hidden objects** Child to remember where the multiple characters hide together
	Single tap Child to tap a single stationary target as fast as they can		**Odd one out** Child to touch the object that is different from the other three
	Alternate tap Child to tap two stationary targets alternately as fast as they can		**Matching shapes** Child to drag the objects to their matching shadow
	Popping balloons Child to tap moving targets as fast as they can		**Jigsaw** Child to drag the parts of the animal to its shadow to make a whole
	Grow your garden Child to touch the target while not touching the distractor		

Methodology

- DEEP and anthropometry data was collected from 1359 3-year-old-children in rural Haryana, who had previously been part of the SPRING cluster-randomized controlled trial
- DEEP data from 200 children was used to train a machine learning algorithm to predict their Bayley's Scale of Infant and Toddler Development (BSID-III) cognitive domain score. This algorithm predicted the DEEP score of the remaining 1159 children
- Associations between cognition at 3-years and a) growth at 1, 1.5 and 3 years, and b) early life adversities at 1 year were done using multilevel modelling, with cluster as the random effect and intervention allocation arm as a fixed effect
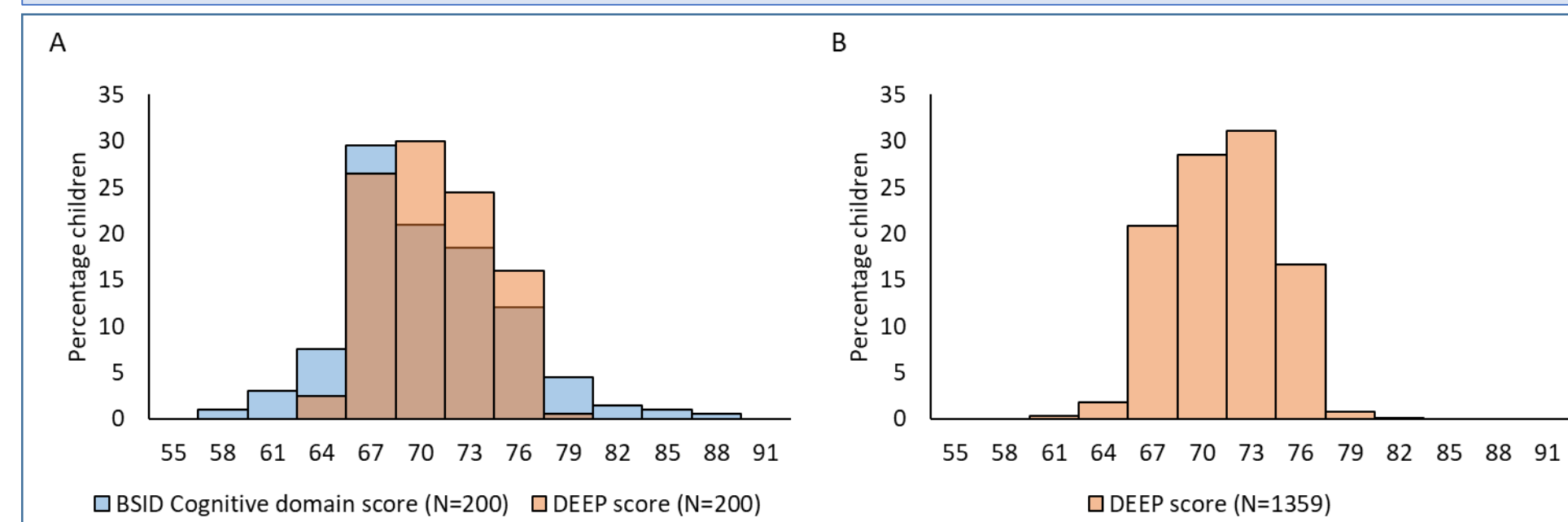
Results

Figure 1: Distribution of (A) DEEP score compared to BSID cognitive domain score (N=200) and (B) DEEP score (N=1359)
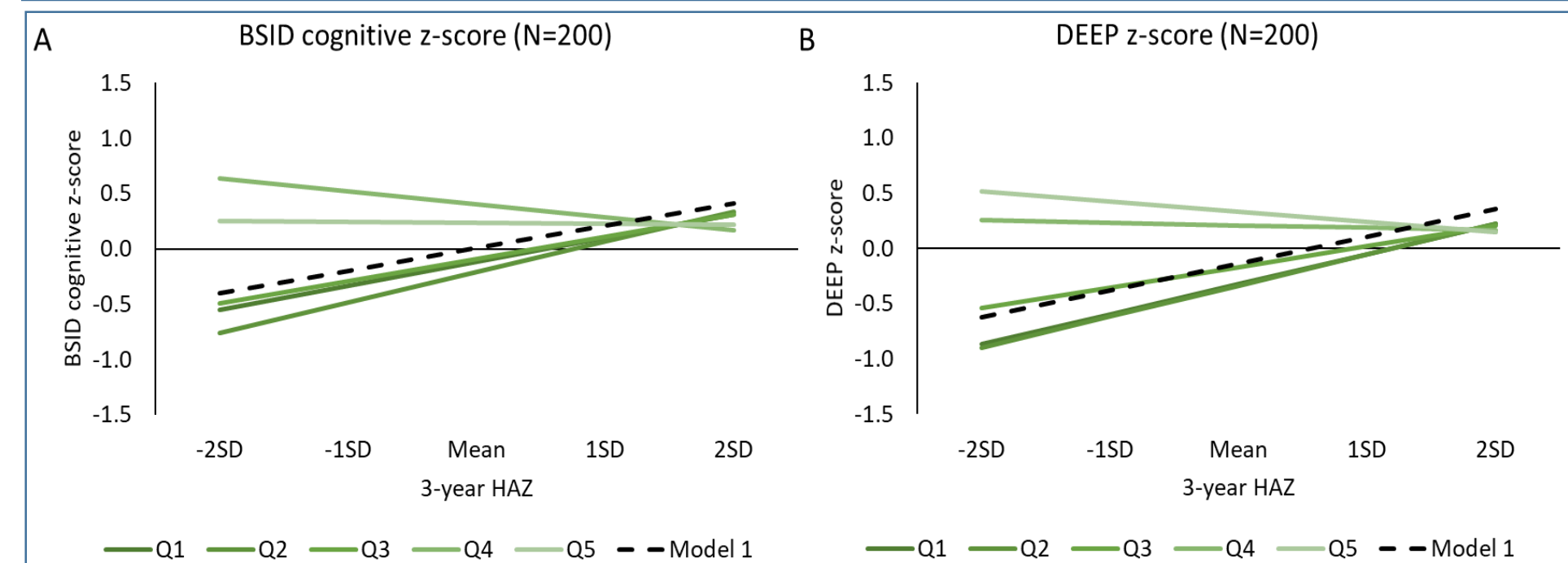

Figure 2: The positive concurrent association between HAZ and cognition is similar when measured by (A) BSID-III and (B) DEEP at 3-years (N=200)
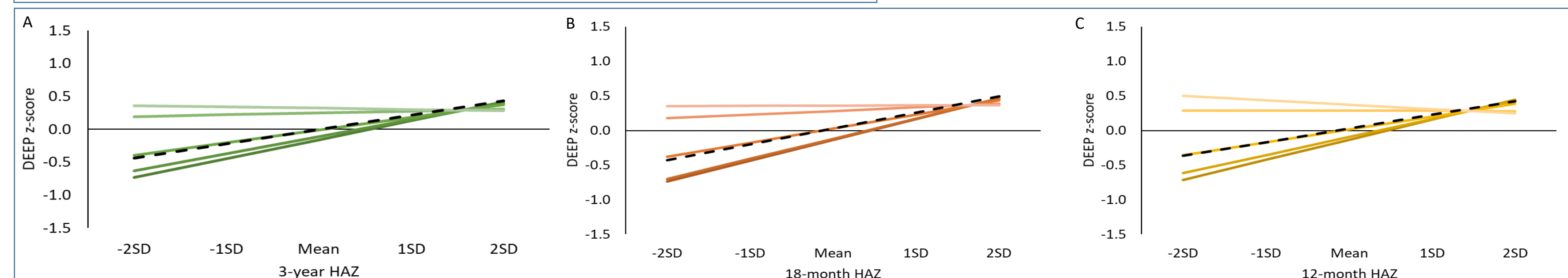

Figure 3: The positive concurrent and prospective associations between cognition measured at 3-years and HAZ measured at (A) 3-years, (B) 18-months and (C) 12-months is similar
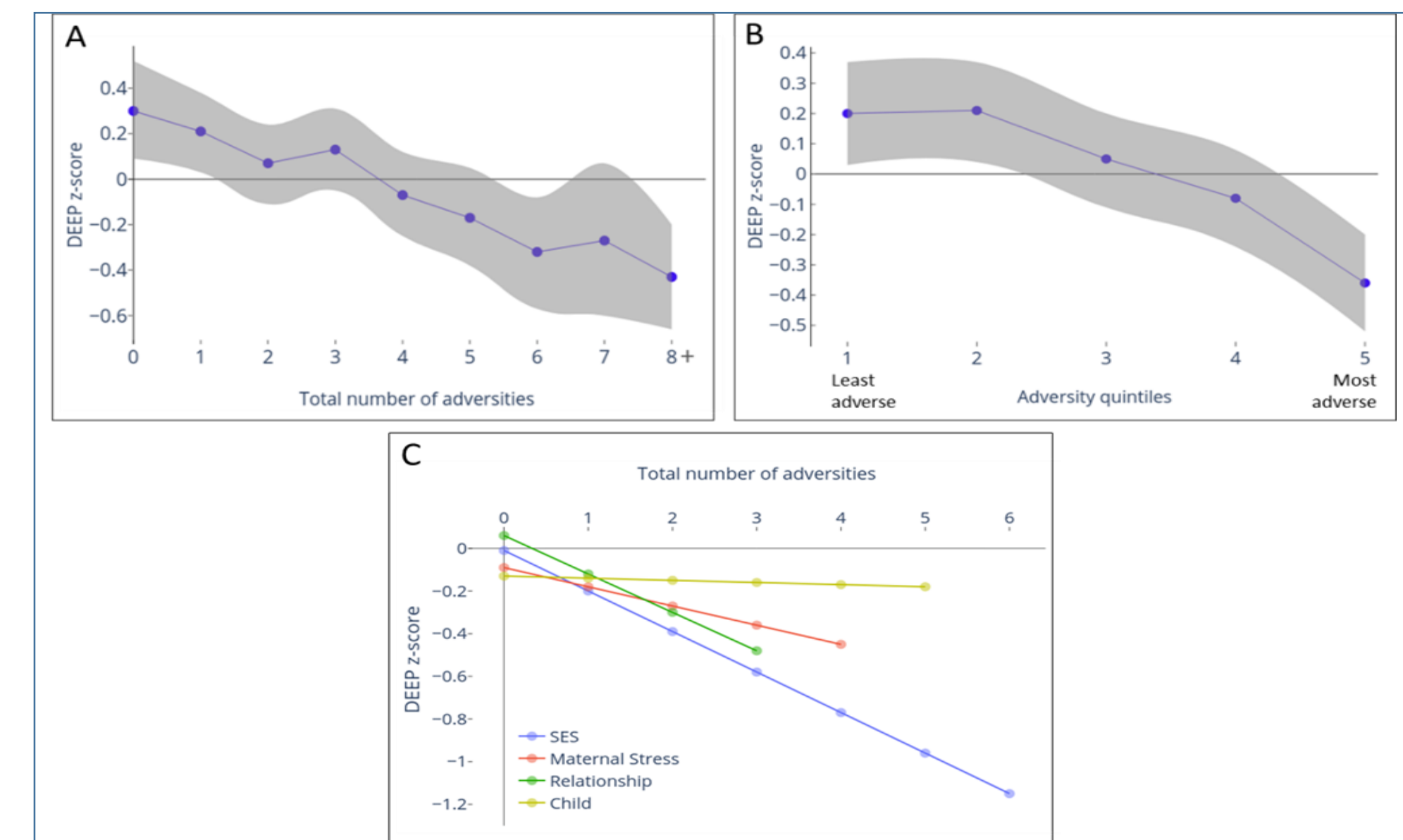

Figure 4: Negative prospective associations between cognition measured at 3-years and early life adversities represented as (A) total number, (B) quintiles and (C) classified into SES, maternal stress, relationship and child domains

Conclusions

Our results demonstrate that DEEP is able to capture:
1. the positive concurrent and prospective association between growth and cognition
2. the persistent effects of early adversities on cognition at three years, which aligns with the literature demonstrating long-term and detrimental effects of early adversities and chronic stress on child outcomes
Based on this evidence, we suggest the utility of DEEP, a scalable, digital cognitive assessment tool, to measure cognition in preschool children. Further validation in different and larger datasets is necessary to confirm our findings.