Digital games to support childhood cognitive and mental health after the COVID-19 pandemic

Hannah Kirk[1], Megan Spencer-Smith[1], Laura Jobson[1], Elizabeth Nicolaou[1], Kim Cornish[1], Ebony Melzak[2], Caitlin Hrysanidis[1], Cassie Moriarty[1], Jeggan Tiego[1], Theoni Whyman[1],Mannat Verma[1] & Mark Bellgrove[1].

1. Turner Institute for Brain and Mental Health, School of Psychological Sciences, Monash University, Melbourne, Australia.
2. Faculty of Education, Monash University, Melbourne, Australia.

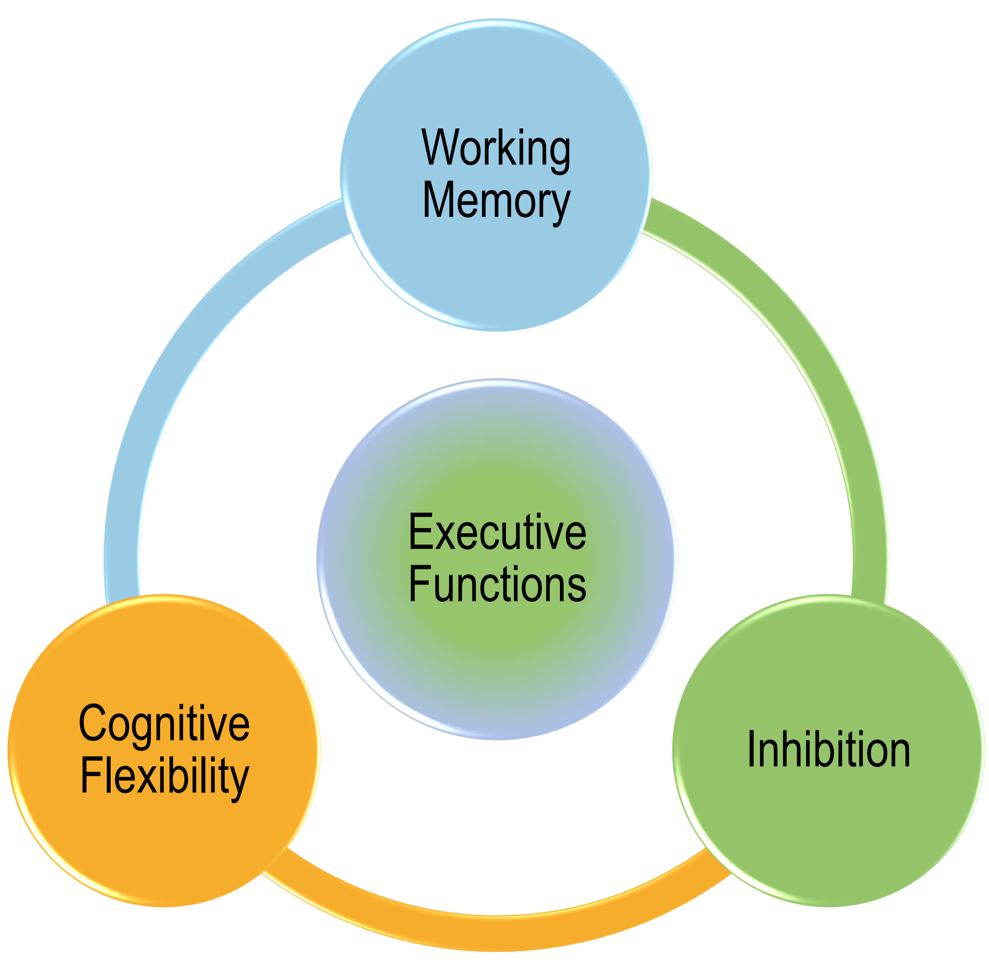
ABSTRACT

Switching attention, keeping track of activities, and staying focused, are critical cognitive skills that are essential to every child as they start school. These skills, known as executive functions, provide the building blocks that support school readiness and social functioning. Children living in remote/regional communities are at particularly risk of impairment in these cognitive skills due to reduced educational engagement and poorer access to interventions. This vulnerability has been exacerbated by the COVID-19 pandemic and strategies are needed to mitigate long-term negative impacts. In partnership with schools across Victoria, we have designed, developed and piloted a digital training intervention that aims to strengthen key executive functions in primary-school children.

INTRODUCTION

A concerning proportion of primary-school students struggle to master key executive functions in the early school years placing them at risk of pervasive behavioural problems, poor social and emotional development and learning difficulties [1, 2]. Thus, disadvantaging them from the commencement of their education [1-3]. Key executive functions [4, 5] comprise:

- Inhibition: the ability to control impulsive responding
- working memory: the ability to temporarily store and mentally manipulate information, and
- cognitive flexibility: the ability to efficiently shift from one task to the next



Digital cognitive interventions that target specific executive functions in early childhood when the brain is most amenable to change have sustained benefits on early learning and cognitive development.

Our team of developmental and clinical psychologists, neuroscientists, cross-cultural researchers, primary school students and educators across the state of Victoria aimed to design and evaluate a digital game-based intervention designed to strengthen executive functions in primary school children.

References

1. Bull, R., K.A. Espy, and S.A. Wiebe, Short-Term Memory, Working Memory, and Executive Functioning in Preschoolers: Longitudinal Predictors of Mathematical Achievement at Age 7 Years. Developmental Neuropsychology, 2008. 33(3): 205-228.
2. Mazzocco, M.M.M. and S.T. Kover, A Longitudinal Assessment of Executive Function Skills and Their Association with Math Performance. Child Neuropsychology, 2007. 13(1): 18-45.
3. Bull, R. and G. Scerif, Executive Functioning as a Predictor of Children's Mathematics Ability: Inhibition, Switching, and Working Memory. Developmental Neuropsychology, 2001. 19(3): 273-293.
4. Lehto, J.E., et al., Dimensions of executive functioning: Evidence from children. British Journal of Developmental Psychology, 2003. 21(1): 59-80.
5. Miyake, A., et al., The Unity and Diversity of Executive Functions and Their Contributions to Complex "Frontal Lobe" Tasks: A Latent Variable Analysis. Cognitive Psychology, 2000. 41(1): 49-100

CATERPILLAR CREEK

The digital intervention (Caterpillar Creek) involves 6 game-based training exercises that target inhibition, working memory and cognitive flexibility. Each exercise lasts for 3 minutes and adjusts in difficulty based on the students performance. Students receive virtual rewards throughout the program to encourage motivation.

STEP 01 DESIGN

METHODS

We conducted focus groups and design sessions with 87 grade 1-2 students and 13 educators.

RESULTS

- Educators indicated that the biggest challenge students faced was poor concentration
- 87.5% said problems in cognitive skills had a major or large impact on learning.
- 100% had previously used technology to support their teaching, and found these digital tools useful.

STEP 02 PROOF-OF-CONCEPT TRIAL

METHODS

Eighteen grade 1 students were recruited and completed the intervention (approx. 20 minutes) during class-time 2-3 times a week, over a 7-week period. Children completed measures of executive functioning pre-intervention and immediately post-intervention.

RESULTS

- Students were able to complete the outcome measures with no floor or ceiling effects
- Students were able to engage with the intervention independently in the classroom
- Students showed significant improvement in working memory performance from pre to post intervention (t=-3.85, p<.001; see figure 1).
- did not have significant changes in cognitive flexibility or inhibitory control performance.

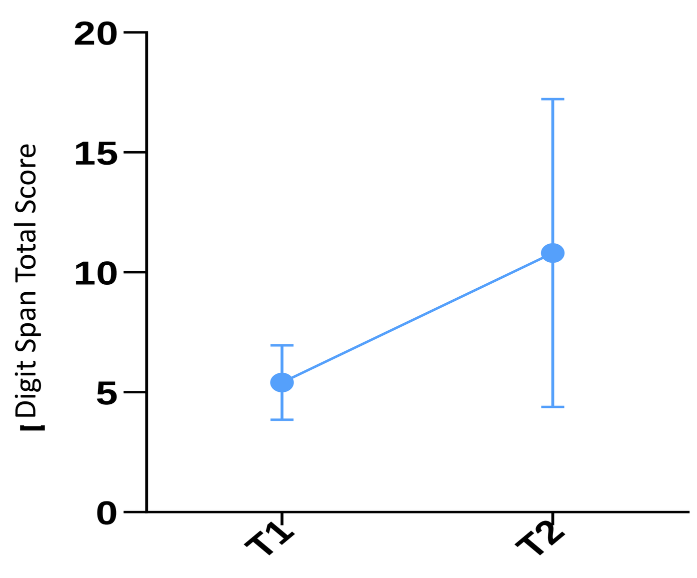


Figure 1.
Improvements in working memory performance pre to post intervention

STEP 03 PILOT TRIAL

METHODS

This study was a parallel-group randomised controlled trial of 116 grade 1-2 students living in regional areas with high rates of childhood developmental vulnerability and socio-economic disadvantage. Students were randomly allocated to the intervention (n = 56) or teaching as usual (n = 60). Children completed measures of executive functioning pre-intervention, post-intervention, and 3-month follow-up.

RESULTS

- Students who received the intervention had significant improvements in verbal (t=3.02, p=0.004) and visuospatial (t=3.26, p=.002) working memory from pre-intervention to post-intervention (see figure 2).
- Students in the control condition had similar improvements (p<.05).
- Compliance was low with only 12.5% of students completing the required number of training sessions.

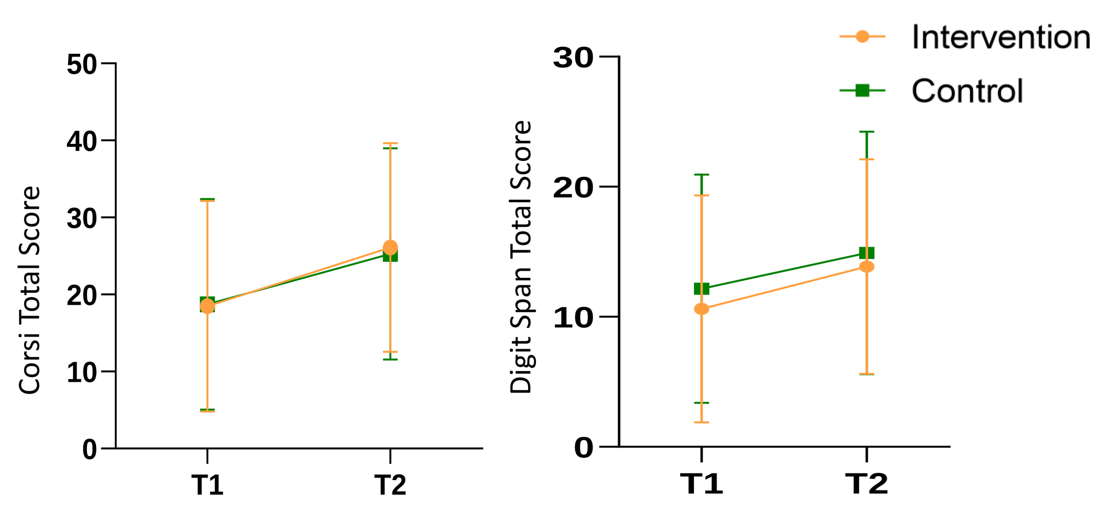


Figure 2.
Improvements in working memory performance pre to post intervention for both intervention and control conditions

CONCLUSIONS

Primary education settings offer an optimal context to deliver interventions as they provide continuity of care and equitable intervention access for all students. However this project identified challenges in delivering digital interventions remotely in the classroom, with concerns from educators centering around the time and resources required to implement specific technology. Additional barriers in relation to student absence and technical issues had a significant impact on intervention engagement. Although the intervention may have benefits in supporting executive functions, larger studies with higher compliance are required. Efforts should be directed to maximizing effective delivery of school-based interventions, particularly in remote and regional communities.

The Ian Potter Foundation

MONASH University