

THE CO-DEVELOPMENT OF MOTOR SKILLS AND EXECUTIVE FUNCTION IN CHILDREN WITH AUTISM



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Today's Overview

- 1) Definition and importance of executive function (EF) and motor skills for healthy development
- 2) Children with ASD
- 3) EF and motor skills in children with autism
- 4) How relations may differ for children in different cultural contexts



Definition of Executive Function

- Executive Function: cognitive processes of attention, working memory, and inhibitory control that lay the foundation for self-regulation.
- Self-Regulation: the conscious control of thoughts, feelings and behavior.



Blair, 2016; McClelland et al., 2015; Nigg, 2017

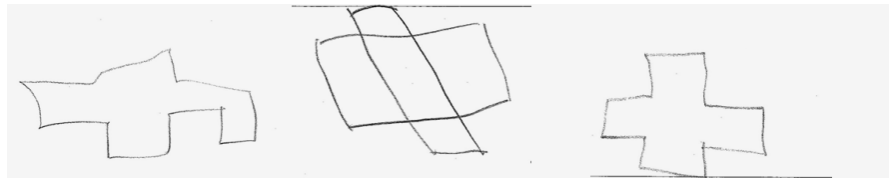
Importance of EF for Healthy Development

EF has emerged as a key predictor for a variety of short- and long-term outcomes including (e.g., Robson et al., 2021):

- Social competence in children (Robson et al., 2021)
- Short and long-term academic success
 - In one study, children with strong attention/persistence at age 4 had nearly 50% *greater odds* of completing university by age 25 (McClelland et al., 2013).
- Long-term physical and mental health, educational outcomes, wages, and employment (Moffitt et al., 2013; Robson et al., 2021)

Definition of Motor Skills

- EF and motor skills, are foundational for learning (Cameron et al., 2012; Grissmer et al., 2010; McClelland & Cameron, 2018)
- Gross motor skills are important for daily activities like walking, running, wheeling, lifting and throwing
- Fine motor skills (such as visuo-motor integration; VMI) involve coordinating visual perceptions with motor movements and measures often require copying a geometric shape
 - VMI has been positively linked to children's school success such as literacy and mathematics (Cameron et al., 2012)



Autism spectrum disorder

DSM IV (1994)

DSM IV TR (2000)

DSM V (2013)

DSM V TR (2022)

Challenges with social communication and interaction skills

Restricted and repetitive interests



Autism and motor skills



Original Descriptions

- Clumsiness (1940's)



Young Children

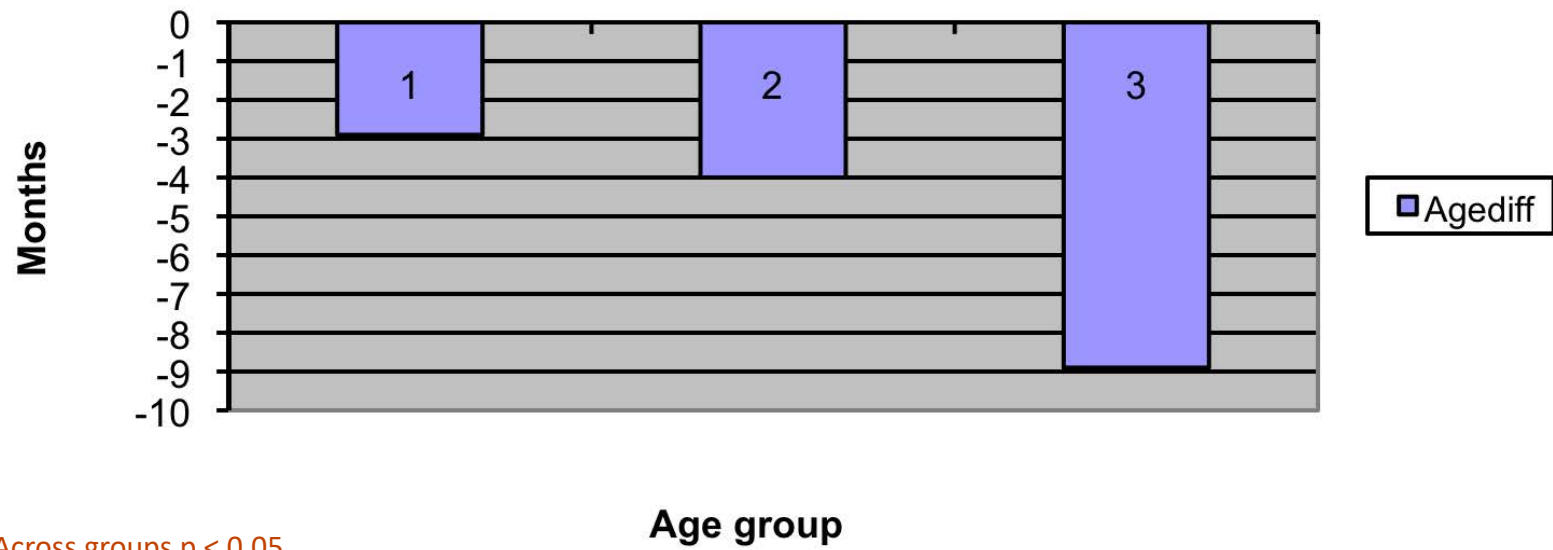
- Delays in motor milestones
- Prominence between 14- 24 months
- Potential diagnostic markers



School-aged children

- Qualitatively different
- Fundamental motor deficits

Gross Motor Age Deficits



Across groups $p < 0.05$

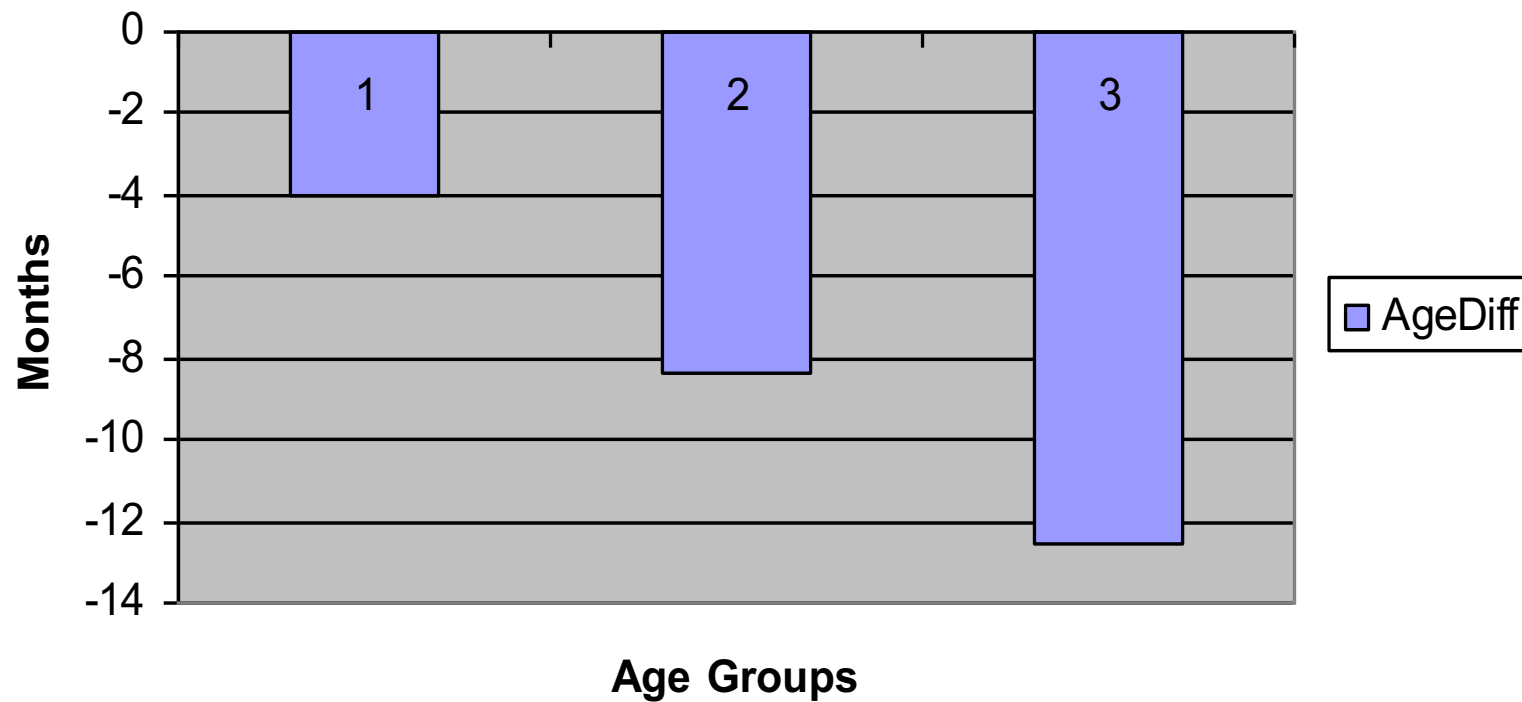
12-24
months

25-30
months

31-36
months

(Lloyd, MacDonald & Lord, 2013)

Fine Motor Age Difference Scores



Across groups $p < 0.001$

12-24
months

25-30
months

31-36
months

(Lloyd, MacDonald & Lord, 2013)

School-aged children



Staples & Reid, 2010

Good news!



EF in Children Experiencing Early Risk

- Accumulating research suggests that these skills are an important *buffer* for children experiencing early risk (Blair & Raver, 2015; Sektnan, McClelland et al., 2010).
- EF deficits have been reported in performance of planning, inhibition of responses, and self-monitoring for children with ASD.



Executive Function and Motor Skills



- EF and motor skills may co-develop in young children in bidirectional and synergistic ways (Becker et al., 2014; Cameron et al., 2015; McClelland & Cameron, 2019).
- Brain areas involved in motor activity (e.g., cerebellum and basal nuclei), are also associated with cortical systems involved in executive function (Davis et al., 2010; Diamond, 2000).
- EF (e.g., working memory, inhibitory control) are related to fine motor skills (Becker et al., 2014; Cameron et al., 2015).
- Although positively related, EF and fine motor skills are not the same (Becker et al., 2014; Cameron et al., 2015; Cameron et al., 2012; MacDonald et al., 2016).
- Traditionally these constructs have been studied independently, however more recently it's been determined that these two constructs are interrelated.

Research on EF and Motor Skills in Children with Autism

- A paucity of empirical research in this area, however evidence of a relationship between EF and MS is emerging in children with ASD.
- Fine motor skills and balance were significantly correlated with cognitive flexibility, among school aged children with ASD
- Until recently, this work has primarily been conducted in western countries



Motor Skill Development and Cultural Context

- Research has shown that Chinese children exhibited better fine motor skill performance, while American children demonstrate better object control skills.
- When the gross motor skills of pre-school children in Hong Kong were compared to American children performance scores were significantly lower.



EF and MS in children with ASD in Taiwan and the United States

- Recently we conducted a study with the following purpose:
 - To examine the relationship between parent ratings of motor skills and executive function in children with ASD in the United States and Taiwan.



Method

- One hundred and seventy-two parents/legal guardians of children (4–6 years and 11 months old) with ASD were recruited from two countries, Taiwan ($n = 100$) and the United States ($n = 72$).

Method

- The parents or guardians of the child with ASD completed a questionnaire including demographic information, child's motor skills (using Children Activity Scale – Parents, ChAS-P), and child's EF (using Childhood Executive Functioning Inventory, CHEXI).
- A series of hierarchical multiple regressions were conducted to determine whether ChAS-P (total motor score, fine motor skills, and gross motor skill) was associated with CHEXI (total EF score, working memory, and inhibition), after controlling for covariates (i.e., age, gender, race, body mass index, whether children received physical activity or cognitive training, parental education level).

Results

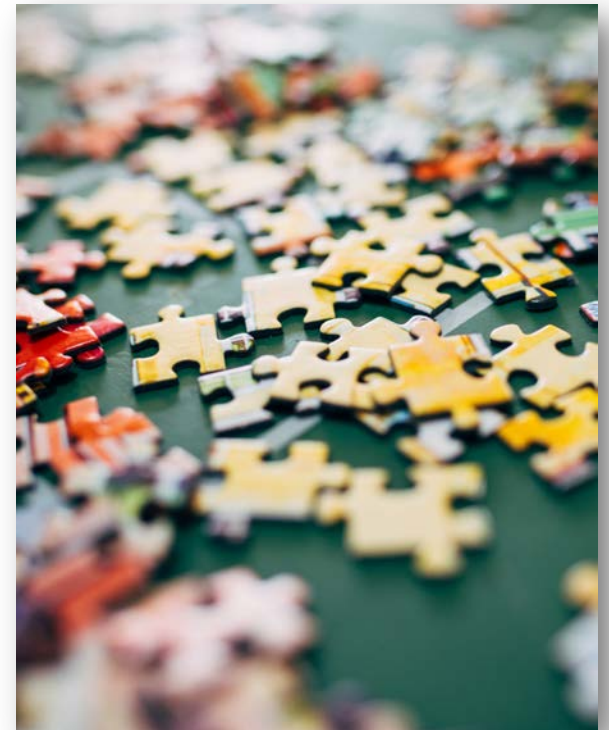
- We found that motor skills were associated with EF as rated by parents in both countries.

Research on EF and Motor Skills in Children with Autism

- We found that ratings between motor skills and EF in children with ASD did not depend on country
- These relationships were culturally comparable, with significant and positive correlations of magnitude in both countries.
- No research, to date, has explored the link between motor skills and EF in young children with ASD cross-culturally.

Conclusion

- EF and motor skills are foundational skills that contribute to school success and healthy development for children from diverse backgrounds.
- Children with ASD struggle with EF and MS, but these are malleable skills and can be improved.
- Our recent research found that relations between MS and EF for children with ASD do not differ for children in the US and Taiwan



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Questions?



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