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Inhibitory Control as a Possible Mediator in the Relation Between Pretend Play and Math Skills During Early Childhood

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Abstract

Inhibitory control is one of the most appropriate measures of executive function in preschool aged children.[1] Inhibitory control positively correlates with academic skills during early childhood.[2, 3] Specifically, mathematical ability has a stronger relation with inhibitory control than do other academic skills (e.g., literacy).[2] Both inhibitory control and mathematical ability are associated with activation and development of the prefrontal cortex.[3] Cool inhibitory control—as opposed to hot inhibitory control—involves regulating behavior in situations void of personal or emotional relevance. Cool inhibitory control has a stronger correlation with mathematical ability than does hot inhibitory control.[4] Interestingly, inhibitory control also correlates with greater relative frequency of pretend play actions and pretense representation.[5] Again, cool inhibitory control displays a stronger correlation with pretend play than hot inhibitory control.[5] Previous research also showed that a lack of pretend play in children may negatively affect the development of their prefrontal cortex.[6] Therefore, we propose that early pretend play might facilitate the development of inhibitory control, which, in turn, would advance the development of executive function and math skills. Thus, inhibitory control might serve as a mediator in the relation between early pretend play and later-developing math skills.

References

1. Carlson, S. M., Moses, L. J., & Breton, C. (2002). How specific is the relation between executive function and theory of mind? Contributions of inhibitory control and working memory. *Infant and Child Development: An International Journal of Research and Practice, 11*(2), 73–92. doi:10.1002/icd.298
2. Allan, N. P., Hume, L. E., Allan, D. M., Farrington, A. L., & Lonigan, C. J. (2014). Relations between inhibitory control and the development of academic skills in preschool and kindergarten: A meta-analysis. *Developmental Psychology, 50*(10), 2368–2379. doi:10.1037/a0037493
3. Willoughby, M. T., Kupersmidt, J. B., & Voegler-Lee, M. E. (2012). Is preschool executive function causally related to academic achievement? *Child Neuropsychology, 18*, 79–91. doi:10.1080/09297049.2011 .578572
4. Brock, L. L., Rimm-Kaufman, S. E., Nathanson, L., & Grimm, K. J. (2009). The contributions of hot and cool executive function to children's academic achievement, learning-related behaviors, and engagement in kindergarten. *Early Childhood Research Quarterly, 24*, 337–349. doi:10.1016/j.ecresq.2009.06.001
5. Carlson, S. M., White, R. E., & Davis-Unger, A. C. (2014). Evidence for a relation between executive function and pretense representation in preschool children. *Cognitive Development, 29*, 1–16. doi:10.1016/j.cogdev.2013.09.001
6. Lillard, A. S. (2017). Why do the children (pretend) play?. *Trends in Cognitive Sciences, 21*(11), 826–834. doi:10.1016/j.tics.2017.08.001

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Inhibition, Math, & Pretend Play

Inhibitory control, also commonly called effortful control, is the cognitive function of inhibiting or acting against one's own natural impulses. Inhibitory control is one of the most appropriate measures of executive function during early childhood (Carlson, Moses, & Breton, 2002). Mathematical ability, for example, has a strong relation with inhibitory control that is stronger than other academic skills (e.g., literacy) (Allan et al., 2014). Inhibitory control in early childhood also acts as a predictor for acquisition of mathematical skills later in life (Clark, Pritchard, & Woodward, 2010). Interestingly, inhibitory control also correlates with greater relative frequency of pretend play actions and pretense representation (Carlson, White, & Davis-Unger, 2014).

Pretend play functions as a way for children to practice or develop their inhibition. Children must make choices—and inhibit others—about what they are pretending. Similarly, math requires inhibition, as suppressing distracting information or neglecting other related processes is necessary.

Hot vs Cool Inhibitory Control

Inhibitory control can be divided into two groups: hot and cool. Hot inhibitory control describes inhibition of impulses that are emotionally stimulating or personally and directly affecting an individual. For example, a child that successfully waits five minutes in front of a marshmallow before eating it to receive an additional one would be exhibiting hot inhibitory control. Cool inhibitory control describes inhibition in abstract or hypothetical scenarios that may not direct affect the individual.

For example, a child that suggests a hypothetical character should wait five minutes in front of a marshmallow before eating it to receive an additional one would be exhibiting cool inhibitory control. Previous research has found cool inhibitory control to have a stronger correlation with mathematical ability than hot inhibitory control does in early childhood (Brock et al., 2009). Cool inhibitory control has a stronger positive correlation with frequency of pretend play and pretense representation than hot inhibitory control as well (Carlson, White, & Davis-Unger, 2014).

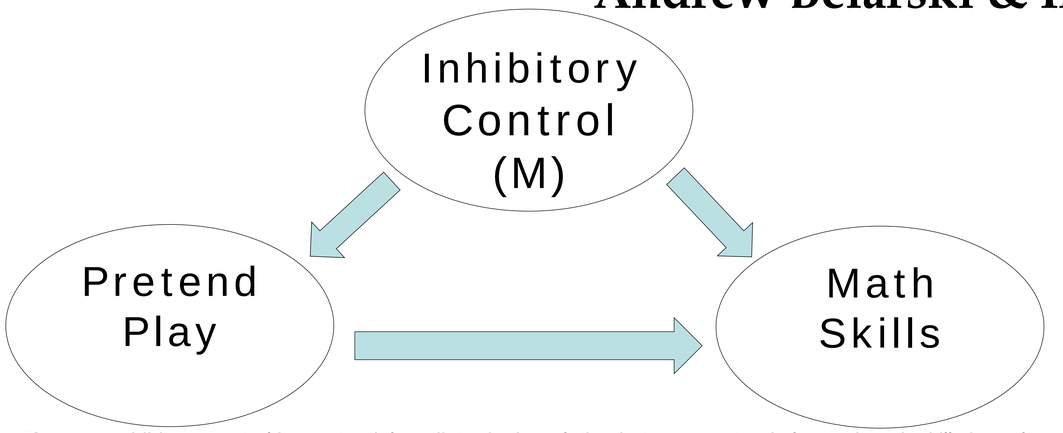

Figure 1. Inhibitory Control is a potential mediator in the relation between pretend play and math skills in early childhood. More research is needed to empirically confirm inhibitory control as a mediator.

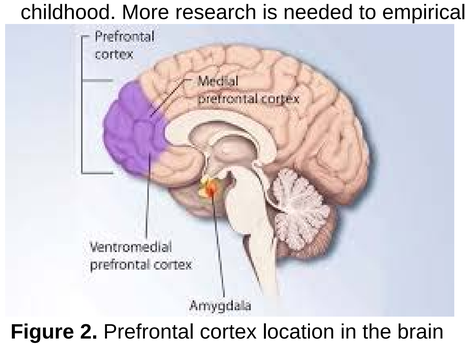

Figure 2. Prefrontal cortex location in the brain

Figure 3. Child exhibiting inhibitory control by refraining from cupcakes

Biological Similarities

Mathematical ability and pretend play share biological similarities. The prefrontal cortex is a region of the human brain located on the anterior frontal lobe and is responsible cognition and decision-making.

Inhibition has been linked to the prefrontal cortex (Rubia et al., 2003). Neurons in the prefrontal cortex are also activated while doing math in early childhood (Willoughby et al., 2012). Additionally, the practice of mathematics has been found to cause growth and development of the prefrontal cortex (Willoughby, Kupersmidt, & Voegler-Lee, 2012; Blair et al., 2005).

A relevant relation is present with pretend play as well. Previous research has suggested that a deprivation of pretend play is associated with less activity, stunted development, and weakened synapses in the prefrontal cortex (Lillard, 2017).

References

Allan, N. P., Hume, L. E., Allan, D. M., Farrington, A. L., & Lonigan, C. J. (2014). Relations between inhibitory control and the development of academic skills in preschool and kindergarten: A meta-analysis. *Developmental Psychology*, *50*(10), 2368–2379. doi:10.1037/a0037493

Blair, C., Gamson, D., Thorne, S., & Baker, D. (2005). Rising mean IQ: Cognitive demand of mathematics education for young children, population exposure to formal schooling, and the neurobiology of the prefrontal cortex. Intelligence, 33(1), 93-106. doi:10.1016/j.intell.2004.07.008

Brock, L. L., Rimm-Kaufman, S. E., Nathanson, L., & Grimm, K. J. (2009). The contributions of hot and cool executive function to children's academic achievement, learning-related behaviors, and engagement in kindergarten. Early Childhood Research Quarterly, 24, 337– 349. doi:10.1016/j.ecresq.2009.06.001

Carlson, S. M., Moses, L. J., & Breton, C. (2002). How specific is the relation between executive function and theory of mind? Contributions of inhibitory control and working memory. Infant and Child Development: An International Journal of Research and Practice, 11(2), 73-92. doi:10.1002/icd.298

Carlson, S. M., White, R. E., & Davis-Unger, A. C. (2014). Evidence for a relation between executive function and pretense representation in preschool children. Cognitive Development, 29, 1–16. doi:10.1016/j.cogdev.2013.09.001

Clark, C. A. C., Pritchard, V. E., & Woodward, L. J. (2010). Preschool executive functioning abilities predict early math achievement. Developmental Psychology, 46, 1176 –1191. doi:10.1037/a0019672

Lillard, A. S. (2017). Why do the children (pretend) play?. Trends in cognitive sciences, 21(11), 826-834. doi:10.1016/j.tics.2017.08.001

Rubia, K., Smith, A. B., Brammer, M. J., & Taylor, E. (2003). Right inferior prefrontal cortex mediates response inhibition while mesial prefrontal cortex is responsible for error detection. Neuroimage, 20(1), 351-358. doi:10.1016/S1053-8119(03)00275-1

Willoughby, M. T., Kupersmidt, J. B., & Voegler-Lee, M. E. (2012). Is preschool executive function causally related to academic achievement? Child Neuropsychology, 18, 79 –91. doi:10.1080/09297049.2011.578572

Conclusions

Through mathematical ability and pretend play's common correlation to inhibitory control and executive function, similar relative strength of relation between hot and cool inhibitory control, and shared activity region in the brain, it is evident that math and pretend are linked in early childhood. Future research should focus on finding a mediating effect from inhibitory control empirically.