Examining the Role of Physical Activity on Word Learning in School-aged Children

Madison Pruitt & Giovanna Morini
University of Delaware
2020 Capstone Presentation, Newark, DE

COMMUNICATION Sciences & Disorders

SLAM LAB
Speech Language Acquisition & Multilingualism

BACKGROUND

- Studies show that there is increased brain activity after exercise - leading to improved naming capabilities (Salis, A.S., 2013; see also Winter et. al, 2007; Miles & Hardman, 1998).
- Previous research examining the effects of different types of exercise: aerobic (e.g., swimming or walking) and anaerobic (e.g., CrossFit) exercise on learning abilities has been conducted with adults (e.g., Winter et. al, 2007), but this study focuses on the effects with children.

PURPOSE

- To examine whether exercise may lead to improvements in word learning in young children. Furthermore, to evaluate whether different types of exercise contribute differently to word learning.

ACKNOWLEDGEMENTS

This work was supported by the University of Delaware. Thanks go to the local CrossFit gym and pool for allowing us to use their facilities,. We also thank the following individuals for helpful discussions regarding the project, and for assistance in testing and coding of participants: Emily Fritzson, Aurora Reible-Gunter, Katherine Richard, Mackensie Blair, Ben Cushman, Silpa Annavarapu, Katrina Conner, Mariann Angela Agapito, Sophia Emery, Brianna Postorino, Sarah Blum, Aashaka Desai, Kat Filliben, Chaithra Reddy, Sarah Dombroski, and Lauren Mellor.

REFERENCES

Gligoroska, J. P., & Manchevska, S. (2012). The effect of physical activity on cognition - physiological mechanisms. Materia Sociomedica, 24(3), 198–202. doi:10.5455/msm.2012.24.198-202
Huang, T., Larsen, K. T., Ried-Larsen, M., Møller, N. C., & Andersen, L. B. (2014). The effects of physical activity and exercise on brain-derived neurotrophic factor in healthy humans: A review. Scandinavian Journal of Medicine & Science in Sports, 24(1), 1-10.
Miles, C., & Hardman, E. (1998). State-dependent memory produced by aerobic exercise. Ergonomics, 41(1), 20-28.
Salis, A. S. (2013). Proactive and reactive effects of vigorous exercise on learning and vocabulary comprehension. Perceptual and motor skills, 116(3), 918-928.
Vaynman, S., Ying, Z., & Gomez-Pinilla, F. (2003). Interplay between brain-derived neurotrophic factor and signal transduction modulators in the regulation of the effects of exercise on synaptic-plasticity. Neuroscience, 122(3), 647-657.
Winter, B., Breitenstein, C., Mooren, F. C., Voelker, K., Fobker, M., Lechtermann, A., ... & Knecht, S. (2007). High impact running improves learning. Neurobiology of learning and memory, 87(4), 597-609.

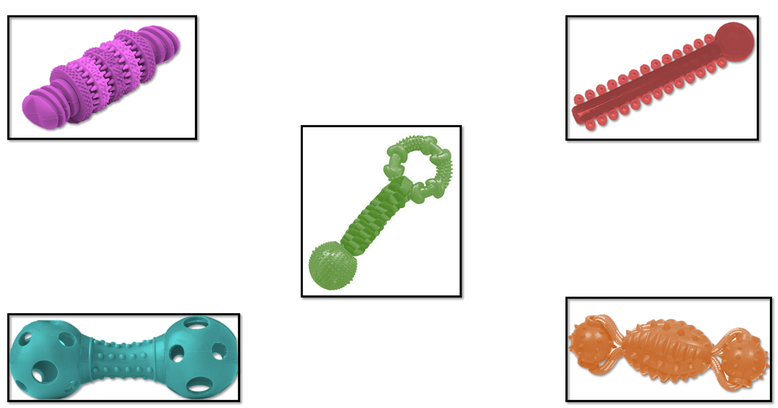
MATERIALS & METHODS

Participants:
Aerobic (swimming) group: 24 children ages 6 to 12 participated to date
(14 males, 10 females - mean age 8.96 years)
Anaerobic (CrossFit) group: 24 children ages 6 to 12 participated to date
(16 males, 8 females – mean age 9.54 years)

Procedure:
Children were taught five new words (e.g., *toopah)* that corresponded to five novel objects.

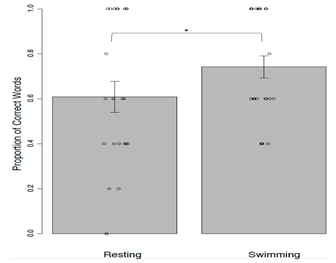
- *Resting* condition – The researcher produced the word and simultaneously showed a picture of the corresponding object (e.g., *This is a toopah. This is a toopah. This is a toopah.).* Then, the child engaged in three minutes of coloring before being tested.

- *Exercise* condition – The researcher produced the word and simultaneously showed a picture of the corresponding object (e.g., *This is a toopah. This is a toopah. This is a toopah.).* Then, the child engaged in three minutes of exercise, either aerobic or anaerobic, before being tested.

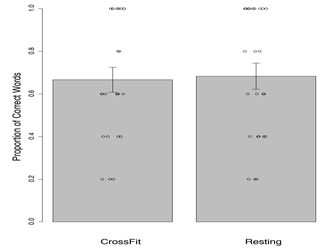


RESULTS

Experiment 1:
- *Resting* condition: ***M*=.61** (*SD*=.34)
- *Aerobic Exercise* condition: ***M*=.74** (*SD*=.24)



Experiment 2:
- *Resting* condition: ***M*** = .68, (***SD*** = .30)
- *Anaerobic Exercise (i.e. Crossfit)* condition: ***M*** =. 67 (***SD*** = .29)



DISCUSSION

The present study is one of the first to focus on the effect of exercise on vocabulary learning in children. As of now, our findings suggest that aerobic exercise facilitates word learning, while anaerobic exercise has no significant effect. These findings provide a potential aid for anyone working with children on word learning (e.g., parent, speech-language pathologists, teachers). Although participants in our study were all typically developing, future studies should consider targeting the following question: Does exercise facilitate word learning in clinical populations (e.g., Autism Spectrum disorder, developmental language disorder (DLD), etc.)?

BACKGROUND

•Studies show that there is increased brain activity after exercise - leading to improved naming capabilities (Salis, A.S., 2013; see also Winter et. al, 2007; Miles & Hardman, 1998)

•Previous research examining the effects of different types of exercise: aerobic (e.g., swimming or walking) and anaerobic (e.g., CrossFit) exercise on learning abilities has been conducted with adults (e.g., Winter et. al, 2007), but this study focuses on the effects with children.

•Brain Derived Neurotrophic Factor (BDNF): molecule used for learning and memory (Gligoroska & Manchevska, 2012; Huang, Larsen, Ried-Larsen, Møller, & Andersen, 2014)

•Exercise increases BDNF production in the brain, specifically in the hippocampus, which facilitates learning (Vaynman, Ying, & Gomez-Pinilla, 2003).

PURPOSE

Aims of the study:

1. **Determine whether exercise may lead to improvements in word learning in young children**

2. **Evaluate whether different types of exercise contribute differently to word learning**

METHODS

Participants:

Aerobic (swimming) group: 24 children ages 6 to 12 participated to date (14 males, 10 females - mean age 8.96 years)

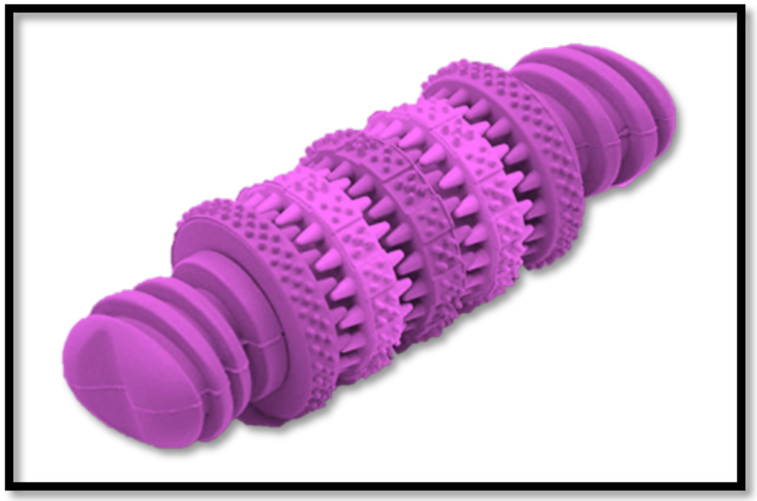
Anaerobic (CrossFit) group: 24 children ages 6 to 12 participated to date (16 males, 8 females – mean age 9.54 years)

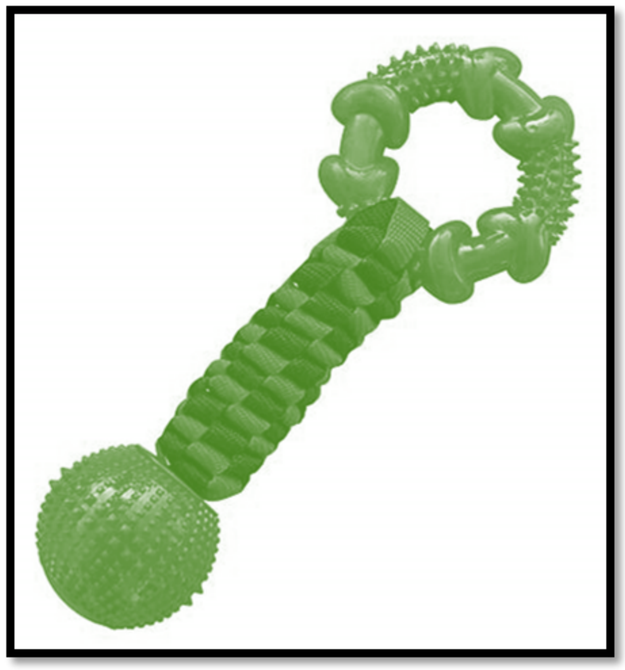
Procedure:

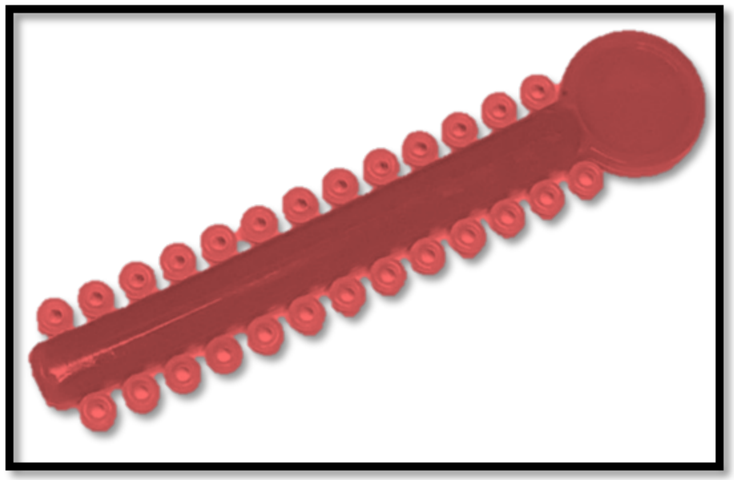
Children were taught five new words (e.g., *toopah)* that corresponded to five novel objects.

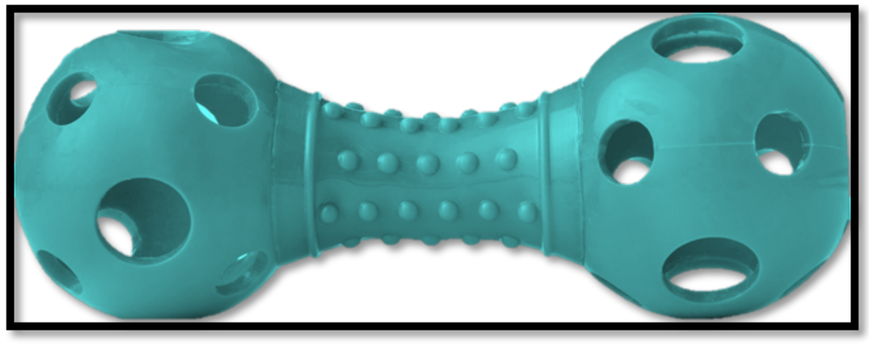
- *Fast mapping* **premeasure**- The researcher produced the word and simultaneously showed a picture of the corresponding object (e.g., *This is a toopah. This is a toopah. This is a toopah.)*.
- *Resting* condition – The researcher produced the word and simultaneously showed a picture of the corresponding object (e.g., *This is a toopah. This is a toopah. This is a toopah.)*. Then, the child engaged in three minutes of coloring before being tested.
- *Exercise* condition – The researcher produced the word and simultaneously showed a picture of the corresponding object (e.g., *This is a toopah. This is a toopah. This is a toopah.)*. Then, the child engaged in three minutes of exercise, either aerobic or anaerobic, before being tested.

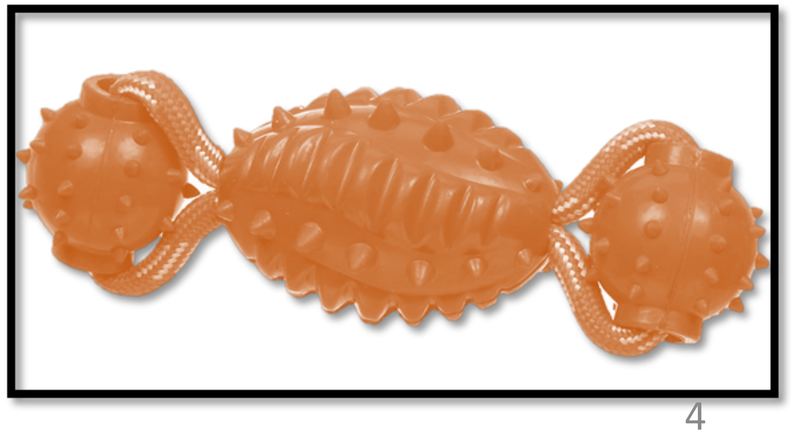
STIMULI











EXPERIMENT 1

Participants:

Aerobic (swimming) group:

24 children ages 6 to 12 participated to date

(14 males, 10 females - mean age 8.96 years)

Procedure:

Children were taught five new words (e.g., *toopah)* that corresponded to five novel objects.

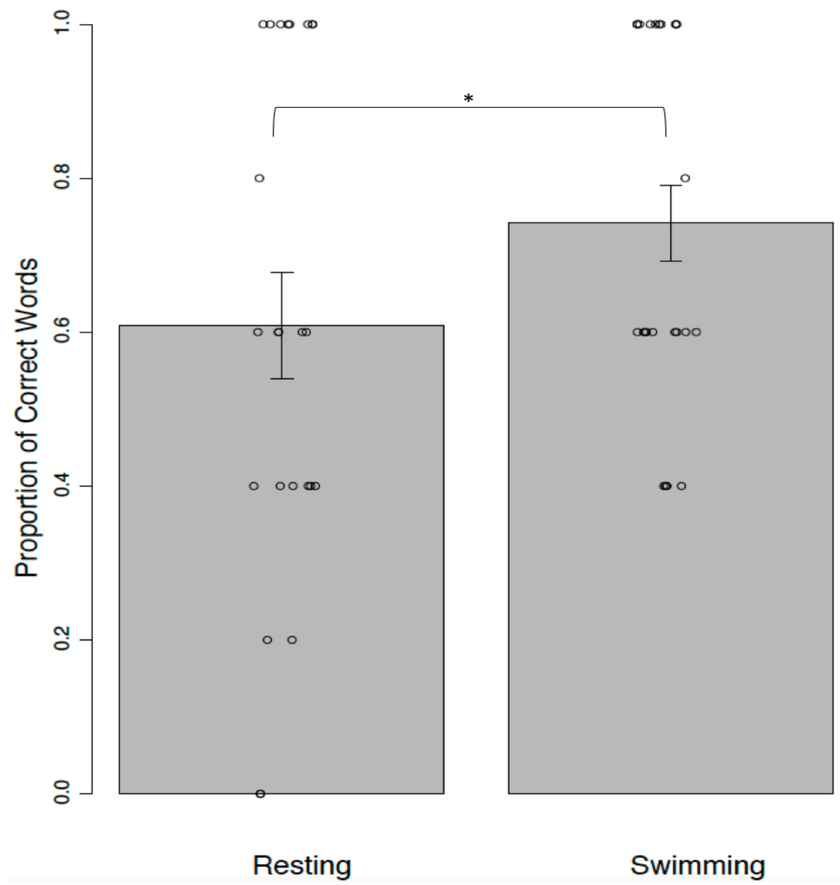
- *Resting* condition

- *Exercise* condition – The researcher produced the word and simultaneously showed a picture of the corresponding object (e.g., *This is a toopah. This is a toopah. This is a toopah.)*. Then, the child engaged in three minutes of swimming before being tested.

RESULTS

- *Fast mapping* premeasure: ***M*=.73** (*SD*= .25)

- *Resting* condition: ***M*=.61** (*SD*=.34)
- *Aerobic Exercise* condition: ***M*=.74** (*SD*=.24)
- Children's ability to acquire novel words improved by **13%** when participants engaged in aerobic exercise between training and testing compared to the rest condition.



EXPERIMENT 2

Participants:
Anaerobic (CrossFit) group:
24 children ages 6 to 12 participated to date
(16 males, 8 females – mean age 9.54 years)

Procedure:
Children were taught five new words (e.g., *toopah)* that corresponded to five novel objects.

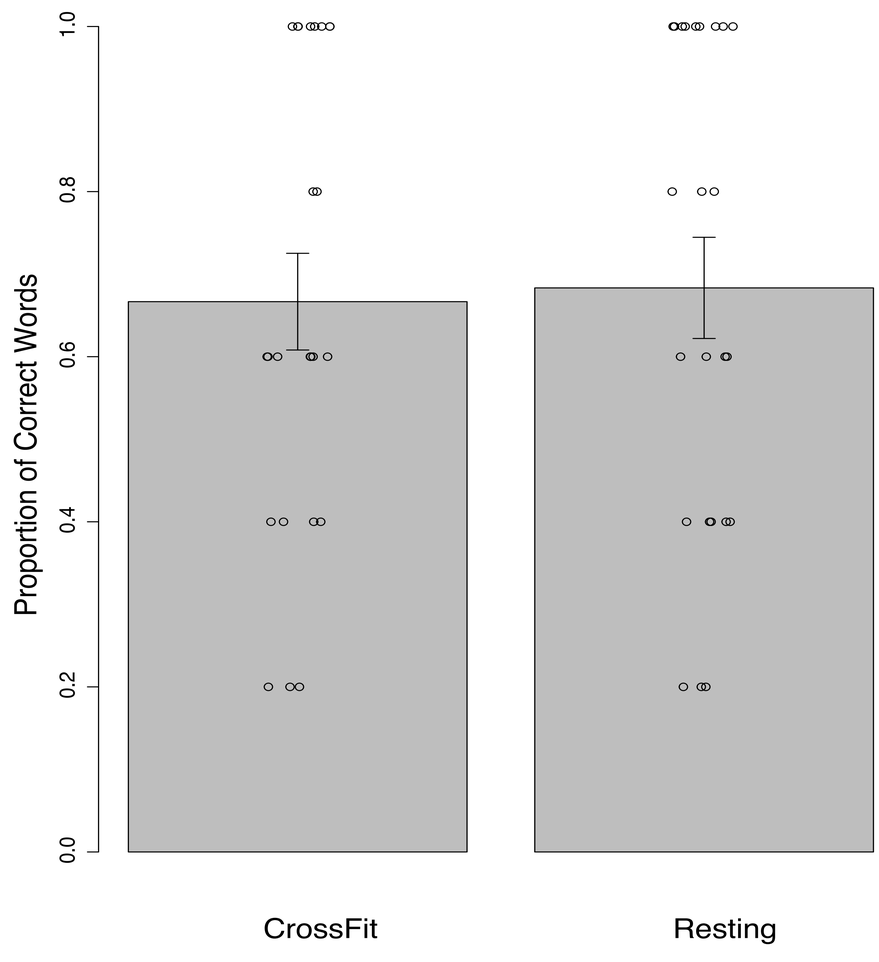
- *Resting* condition

- *Exercise* condition – The researcher produced the word and simultaneously showed a picture of the corresponding object (e.g., *This is a toopah. This is a toopah. This is a toopah.).* Then, the child engaged in three minutes of CrossFit like exercise before being tested.

RESULTS

- *Fast mapping* premeasure: **M** = .80 (***SD*** = .25)

- *Resting* condition: ***M*** = .68, (***SD*** = .30)
- *Anaerobic Exercise (i.e. Crossfit)* condition: ***M*** =. 67 (***SD*** = .29)
- Children's ability to acquire novel words was not negatively affected by anaerobic exercise, this type of exercise did not lead to an improvement in performance



DISCUSSION

In conclusion:

- **Anaerobic exercise** did not appear to have an effect on word learning as compared to the resting condition.
- **Aerobic exercise** appeared to facilitate word learning by **13%** in comparison to rest.

Why is this important?

This study provides a potential strategy for anyone working with children and word learning (e.g., parents, teachers, speech-language pathologists, etc.).

Future directions:

- Does the duration of exercise make a difference in word learning?
- Does exercise facilitate word learning in clinical populations (e.g., Autism Spectrum disorder, developmental language disorder (DLD), etc.)?

REFERENCES

Gligoroska, J. P., & Manchevska, S. (2012). The effect of physical activity on cognition - physiological mechanisms. *Materia Sociomedica*, *24*(3), 198–202. doi:10.5455/msm.2012.24.198-202

Huang, T., Larsen, K. T., Ried-Larsen, M., Møller, N. C., & Andersen, L. B. (2014). The effects of physical activity and exercise on brain-derived neurotrophic factor in healthy humans: A review. *Scandinavian Journal of Medicine & Science in Sports*, *24*(1), 1-10.

Miles, C., & Hardman, E. (1998). State-dependent memory produced by aerobic exercise. *Ergonomics*, *41*(1), 20-28.

Salis, A. S. (2013). Proactive and reactive effects of vigorous exercise on learning and vocabulary comprehension. *Perceptual and motor skills*, *116*(3), 918-928.

Vaynman, S., Ying, Z., & Gomez-Pinilla, F. (2003). Interplay between brain-derived neurotrophic factor and signal transduction modulators in the regulation of the effects of exercise on synaptic-plasticity. *Neuroscience*, *122*(3), 647-657.

Winter, B., Breitenstein, C., Mooren, F. C., Voelker, K., Fobker, M., Lechtermann, A., ... & Knecht, S. (2007). High impact running improves learning. *Neurobiology of learning and memory*, *87*(4), 597-609.

ACKNOWLEDGEMENTS

We particularly thank the families who participated and who made this work possible.

We also thank the following individuals for helpful discussions regarding the project, and for assistance in testing and coding of participants:
Emily Fritzson
Aurora Reible-Gunter
Katherine Richard
Mackensie Blair
Ben Cushman
Silpa Annavarapu
Katrina Conner
Mariann Angela Agapito
Sophia Emery
Brianna Postorino
Sarah Blum
Aashaka Desai
Kat Filliben
Chaithra Reddy
Sarah Dombroski
Lauren Mellor