Working Memory and Attention in Utilizing Aided AAC Displays

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Abstract

AAC gives individuals with intellectual/developmental disabilities a voice. In place of spoken words, users of aided AAC rely on objects, pictures, or written words to convey messages. For many, this use of aided AAC to represent linguistic concepts relies heavily on the visual modality. We examine the working memory and attention demands of aided AAC used by individuals with intellectual/developmental disabilities. Analysis of a prominent working memory model and data from recent research provide initial guidance regarding the consideration of visual characteristics of a display and how these characteristics may influence the demands of AAC.

Attention

Attention is a limited resource, occurs with or without conscious effort and is comprised of multiple factors (Mirsky, et al., 1999; Sohlberg & Mateer, 1989).

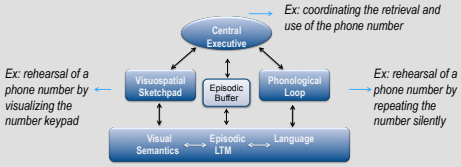
Sustained Attention: the ability to stay on task, inhibit irrelevant input
Selective Attention: the ability to control what or where focus
Divided Attention: the ability to attend to multiple sources of input

** Joint attention will not be covered in this poster.*

Working Memory

Short term memory: storage of input for a limited period of time. Input is forgotten if no further processing is completed. Example: meeting a new person.

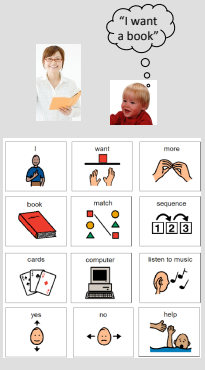
Working Memory: **Storage** and **processing** of input. Processing allows for greater use and remembering of the input.



The Multi-Component Model of Working Memory, Baddeley, 2007

Attention & Working Memory: AAC Demands

To use an AAC display effectively for communication a child must:



Sustain attention in order to hold the intended message and individual words in mind.

Selectively attend to relevant symbols, while ignoring irrelevant or distracting symbols.

Divide attention between the display and intended message

Working memory storage overlaps with sustained attention as the child keeps the target word in mind.

Working memory processing is utilized as the child coordinates the various demands of attention, visual processing, motor movements, social aspects.

For example: To complete the request by saying "book," this child must:
1. Remember his place in the sentence (sustain & processing)
2. Remember his intended target (sustain, storage)
3. Inhibit other targets (selective, divided, processing)
4. Recognize the correct target (processing)
5. Point to the target (processing)

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Attention & Working Memory: What abilities do individuals with developmental disorders have?

Research with children with autism, Down syndrome, and fragile X reveals strengths and weaknesses on various tasks of attention and working memory.

Knowing the strengths and weaknesses of children who may benefit from AAC can help guide our decisions related to designing AAC displays.

	Autism	Down syndrome	Fragile X
Sustained	Relative Strength[5]	Intact[10]	Intact[10]
Selective	Age related Impairments[5]	Impaired[10]	Impaired[10]
Divided	Impaired[1]	Impaired[10]	Impaired[10]
Visual WM	Impaired[8]	Relative Strength[7]	Impaired[3,11]
Verbal WM	Intact[8]	Impaired[7]	Impaired[3,11]

Sample tasks used to measure:
Attention: CPT, visual search
Working Memory: Corsi span, digit span

Predictions

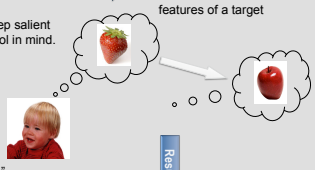
Consider the visuospatial sketchpad. The rehearsal function of inner scribe may support sustained and selective attention.

Rehearsal may keep salient features of a symbol in mind.

Deficits

Difficulties visually rehearsing information.

Difficulties sustaining attention toward salient features of a target



Child selects "apple" instead of "strawberry." The red and round features are retained but the seeds and green leafy stem are not.

This behavior is consistent with the overselectivity often seen in children with autism

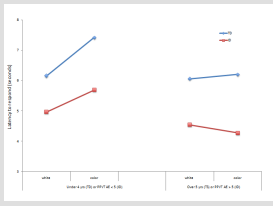
Results

PREDICTION: Individuals with autism and fragile X tend to show deficits on visuospatial tasks. We may see errors due to reduced visual rehearsal and better performance when child is provided with more time to process visual information.

References

1. Althaus, M., de Sonneville, L. M. J., Minderaa, R. B., Hensen, L., & Til, R. (1996). Information processing and aspects of visual attention in children with the DSM-III-R diagnosis "pervasive developmental disorder not otherwise specified" (PDD-NOS): I. focused and divided attention. *Child Neuropsychology, 2*(1) 17 – 29. doi: 10.1080/09297049608401347
2. Baddeley, A. (2007). Working memory, thought and action. Oxford: Oxford University Press.
3. Baker, S., Hooper, S., Skinner, M., Hatton, D., Schaaf, J., Ornstein, P., & Bailey, D. (2011). Working memory subsystems and task complexity in young boys with fragile X syndrome. *Journal of Intellectual Disability Research, 55*(1), 19-29. doi:10.1111/j.1365-2788.2010.01343.x
4. Carelli, R., & Wilkinson, K. M. *Spatial arrangement of symbols on a grid influence speed and accuracy of finding a target by individuals with intellectual and developmental disabilities.* In preparation.
5. Goldstein, G., Johnson, C. R., & Minshew, N. J. (2001). Attentional processes in autism. *Journal of Autism & Developmental Disorders, 31*(4), 433-433.
6. Hoeksma, M., Chantal, K., Kenemans, J., & van Engeland, H. (2006). Abnormal selective attention normalizes P3 amplitudes in PDD. *Journal of Autism and Developmental Disorders, 36*, 643 – 654. doi: 10.1007/s1080-006-0102-5
7. Jarrold, C., & Baddeley, A. D. (1997). Short-term memory for verbal and visuospatial information in down's syndrome. *Cognitive Neuropsychiatry, 2*(2), 101-122. doi:10.1080/135468097396351
8. Joseph, R., McGrath, L., & Tager-Flusberg, H. (2005). Executive dysfunction and its relation to language ability in verbal school-age children with autism. *Developmental Neuropsychology, 27*(3) 361 – 378.

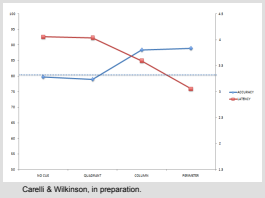
Current Research: Background Color



Data for ID is preliminary; data for TD is reported in Wilkinson & Coombs, 2010.

- Background color cuing may interfere with visual search in children under a 5 year old developmental level.
- Perhaps the color is acting as an additional feature to attend to. When background color is included, the child may separately process "cat" and "yellow" rather than "cat."
- This dual processing adds to the complexity of the task and is likely to be further compounded by any working memory impairments the child may have.

Current Research: Layout



Carelli & Wilkinson, in preparation.

Overall accuracy (blue, higher is better) and speed to respond (red, lower is better) in participants with intellectual disabilities.

- It would appear that although it seems to sacrifice valuable space on a display, the clock pattern results in the most accurate and fastest responding, most certainly relative to no spatial organization and also relative to organization based on quadrants.
- Perhaps this is because in the clock arrangement, each symbol has no more than two direct neighbors, in contrast to the traditional grid where that same symbol can have as many as 8 close neighbors.
- This suggests that attention capabilities will be in greater demand as the child sustains attention to the desired target and selectively inhibits attention to the distracting targets.

Conclusion

Designing an effective display requires consideration of the child's abilities, including those related to attention and working memory. There is now compelling evidence that distinct profiles of attention/memory skills and deficits are associated with disabilities of different etiological origins. It is therefore critical to ensure that the features of AAC displays are well-suited to the processing skills of each individual child. In this poster, we have identified several ways in which the features of an AAC display might tax attention or memory or, alternatively, reduce attention/memory demands. Preliminary analysis of initial data sets supports the value of this approach and provides avenues for further experimental research.

References, continued

9. Mirsky, A. F., Anthony, B. J., Duncan, C. C., Ahearn, M. B., & Kellam, S. G. (1991) Analysis of the elements of attention: a neuropsychological approach. *Neuropsychology Review, 2*(2), 109-145
10. Munir, F., Cornish, K. M., & Wilding, J. (2000). A neuropsychological profile of attention deficits in young males with fragile X syndrome. *Neuropsychologia, 38*(9), 1261-1270. doi:10.1016/S0028-3932(00)00036-1
11. Munir, F., Cornish, K. M., & Wilding, J. (2000). Nature of the working memory deficit in fragile-X syndrome. *Brain and Cognition, 44*(3), 387-401. doi:10.1006/brcg.1999.1200.
12. Sohlberg, M. M., & Mateer, C. (1989). Introduction to cognitive rehabilitation: Theory and practice. New York: Guilford Press.
13. Wilkinson, K. M., & Coombs, B. (2010). Preliminary exploration of the effect of background color on the speed and accuracy of search for an aided symbol target by typically developing preschoolers. *Early Childhood Services, 4*(3), 171-183.
14. Wilkinson, K. M. & Jagaroo, V. (2004). Contributions of principles of visual cognitive science to AAC system display design. *Augmentative and Alternative Communication, 20*(3), 123 – 136.