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Selective Sustained Attention, the Visual Environment, and Learning in Kindergarten-age Children: Preliminary Results of an Individual Difference Study

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Abstract

Prior work has found that selective sustained attention (SSA) is related to young children's task performance and to various indices of academic achievement (e.g., course grades, standardized test scores). However, experimental research demonstrating a link between learning and SSA is lacking. Additionally, much of the existing work is not able to partial out variance in children's learning performance due to individual difference factors. This work examines the putative relationship between SSA, measured as the proportion of time spent off-task, and young children's learning outcomes by yoking measures of time off-task to immediate measures of learning, while controlling for the variance in children's learning performance due to individual difference factors such as IQ, working memory, processing speed, and inhibitory control.

Keywords: Off-Task Behavior; Learning; Attention

Introduction

Improving children's learning outcomes is a central goal for both educators and parents. However, improving learning outcomes is a multifaceted issue with a diverse array of factors hypothesized to influence children's learning progress including: poverty, parental involvement, school based factors such as teacher or district quality, as well as student characteristics (e.g., absenteeism, motivation, aptitude). One factor widely believed to be important to learning is attention. Modulating attention and ignoring extraneous information may be particularly relevant for learning in classroom contexts where children are presented with numerous sources of potential distraction (e.g., peers, displays, announcements).

The present study aims to examine the assumed relationship between selective sustained attention (SSA) and young children's learning outcomes by experimentally inducing lower or higher levels of SSA by introducing or removing visual distractors (e.g., educational displays irrelevant to the learning task) and observing the consequences on children's learning outcomes. This work also aims to identify individual difference factors that may modulate the effect of SSA on children's learning outcomes.

Selective Sustained Attention and Learning

Selective Sustained Attention (SSA) is defined as: "a state of engagement that involves narrowed selectivity and increased commitment of energy and resources on the targeted activity" (Setliff & Courage, 2011, p. 613). SSA is hypothesized to play a critical role in learning, as attention is believed to be important for general cognitive processes such as encoding (Choudhury & Gorman, 2000). Thus, inattention is presumed to negatively impact learning. However, inferences regarding the relationship between SSA and learning are based largely on children's performance on procedural tasks (e.g., sorting shapes, Choudhury & Gorman, 2000; performance on visual discrimination tasks, Higgins & Turnure, 1984) rather than learning per se. Collectively, this work has documented that SSA is related to children's task performance. However, the use of such procedural tasks as an index of learning is problematic as these tasks bear little resemblance to the learning activities that children encounter in the classroom.

Other research studies have utilized academic achievement as an indicator of learning (e.g., Checa & Rueda, 2011; Lehman et al., 2010; Schweizer & Moosbrugger, 2004). An association between SSA (indexed by teacher and parent reports, observations, or laboratory measures of attention) and measures of academic achievement have been documented in school-age children, particularly in the domains of math and reading (e.g., see Duncan et al., 2007 for review). To date, available research suggests a persistent relationship between SSA (indexed by time spent on-task) and achievement; however, studies have found that the strength of the correlation fluctuates widely, ranging between 0.13 and 0.71 (for review see Caldwell, Huitt, & Graeber, 1982; Frederick & Walberg, 1980). Inconsistencies in the correlation strength are a potential cause for concern as increasing attention without improving learning outcomes is unsatisfactory. As Snider (1987) stated poignantly, "increased amounts of time on task …are desirable as a means to the end of increased achievement; otherwise, we simply create well-behaved underachievers" (as cited in Reid & Harris, 1993, p.31).

Individual differences may provide a potential explanation for the observed variability in the correlation strength across the prior literature. Four individual difference factors posited to modulate the relationship between SSA and learning are: IQ, Processing speed, working memory (WM), and inhibitory control. For instance, children with greater WM capacity may need fewer learning opportunities (i.e., less time on-task) to learn the same amount of material as children with lower WM capacity. In contrast, children with better inhibitory control may be better able to resist going off-task in the presence of distractors resulting in more learning opportunities (i.e., more time on-task) and better learning outcomes. A small number of prior studies have included some individual difference factors (e.g., IQ); however, to date no study has looked at genuine learning outcomes while systematically investigating the contribution of multiple individual difference factors. In this paper, we report preliminary findings from the first study that aims to systematically examine these issues.

Method

Participants

The final sample consisted of 44 kindergarten children (*Mage* = 5.46 years, *SD* = 0.44 years, 21 females, 23 males). All participants attended a laboratory school at a private university in Pennsylvania. Children were tested individually in a quiet room adjacent to their classroom by the first author of this paper and trained research assistants.

Design

The present study utilized a within-subject design. The visual environment was the within-subject factor (presence or absence of environmental distractions). There were two experimental conditions: (1) High Visual Distraction (HVD) condition and (2) Low Visual Distraction (LVD) condition. In the HVD condition, environmental distractors consisted of educational displays common in elementary school classrooms (i.e., solar system replica, model tornado, bulletin board, basket of supplies, etc.). In the LVD condition the environmental distractors were removed.

Presentation order of the conditions (HVD first or LVD first) was counterbalanced across participants. The dependent variable was children's accuracy on the learning task in the HVD and LVD condition (i.e., proportion of correct responses). The amount of time children spent off-task was calculated as a measure of children's SSA. A within-subject design was utilized to ensure any learning differences obtained were a result of the experimental manipulation rather than variability across groups of children.

Procedure

Children participated in 10 testing sessions. Each testing session lasted approximately 15 minutes. In sessions 1 and 2, children completed the learning task in the HVD and LVD conditions. These sessions were videotaped for coding purposes in order to calculate the proportion of time children spent off-task. An individual difference assessment battery was administered during the remaining 8 testing sessions. The assessment battery was administered in order to measure pertinent cognitive factors including: general intelligence, processing speed, working memory, inhibitory control, and sustained attention.

Learning Task. The Paired-Associates Learning (PAL) task is a computer-based learning task, which contains three phases: pre-test, learning phase, and post-test. In the pre-test, children were asked to identify the object labeled by the experimenter from 4 pictorial response options. The pre-test included 18 trials, which consist of 9 novel test items and 9 familiar items which served as fillers. Two presentation orders were created. In Order 1 the test items were randomized with the constraint that the pre-test began and ended with a familiar item. For Order 2 the presentation order utilized in Order 1 was simply reversed.

In the learning phase, the children were presented with pictures of the 9 novel animals and taught the corresponding label for each object. Each item was presented three times during the learning phase for a total of 27 trials. Two presentation orders were created. For Order 1 items were blocked and randomized within each block (i.e., 3 blocks each containing the 9 novel items). For Order 2 the presentation order utilized in Order 1 was simply reversed. Each paired-associate trial was presented for a duration of 2 seconds.

The learning phase was designed to approximate 'seat-work,' an independent learning activity common in elementary school classrooms. During seat-work, the teacher typically circulates throughout the classroom assisting individual students as needed. As a result, the amount of direct supervision that a particular child receives during seat-work is typically minimal as the teacher's attention is being distributed across the entire classroom. Consequently, in the present study the experimenter stood in the hallway while the child completed the learning phase of the PAL task independently. Thus, if the child engaged in off-task behavior, the experimenter did not redirect the child.

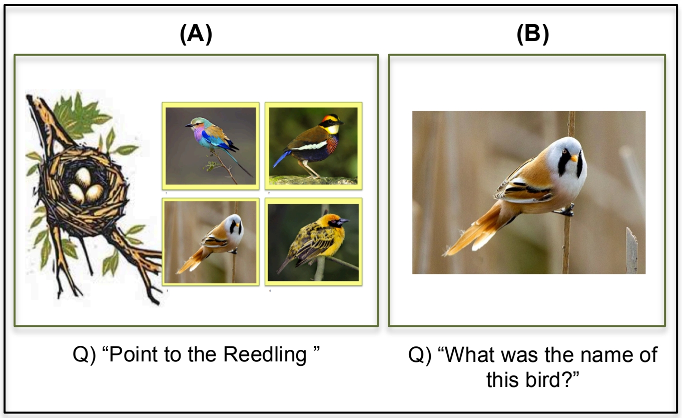

Figure 1. Sample assessment items from the Birds paired-associates learning task. Panel A provides a recognition test item and Panel B provides a recall test item.

The post-test phase included 18 test items. The post-test was composed of recognition and recall test items (9 questions each); see Figure 1. For recognition items, children were asked to point to the animal labeled by the experimenter from 4 pictorial response options. For recall items, children were shown a picture of an animal and asked to recall the item name. Two presentation orders were created. For Order 1 question type was blocked (Block 1: Recognition questions, Block 2: Recall questions) and the items were randomized within each block. For Order 2 the blocking sequence was held constant (Block 1: Recognition questions, Block 2: Recall questions); however, the presentation order of the items within each block was reversed. Two versions of the PAL task were created in which children learned about different types of animals: '*Birds'* and '*Monkeys and Apes.'*

Children completed the PAL tasks under two conditions: (1) under the presence of environmental distractors (HVD) and (2) without distractors present (LVD). Presentation order (HVD first or LVD first) was counterbalanced across participants. PAL version (*Birds* or *Monkeys/Apes*) was also counterbalanced across conditions. Duration of children's off-task behavior as well as PAL accuracy was compared across conditions (HVD vs. LVD).

Coding. PAL sessions were videotaped for coding purposes. Children's behavior was coded at the second-by-second level in order to calculate the proportion of time children spent off-task. Coders were taught to classify the child's behavior as on- or off-task. On-task behavior was operationalized as engagement with the learning materials (i.e., the computer). Engagement was determined by the direction of children's gaze which is a common measure of visual attention (see Henderson & Ferreira, 2004; Just & Carpenter, 1976).

For each instance of off-task behavior, the coders marked the timing of its onset and cessation. Utilizing time off-task as a measure of SSA allows for a more precise examination of the extent to which children are attending to the learning task. All coders were trained by the first author of this paper. Training consisted of extensive practice coding videotapes. A subset of the data (25%) is being re-coded to ensure good inter-rater reliability. The preliminary Cohen's (1960) kappa (0.71) is in line with prior research coding off-task behavior, and it approaches the 0.75 threshold to which Fleiss (1981) refers to as "excellent." All coders are hypothesis-blind.

Individual Difference Assessment Battery

General Intelligence. Participants completed a commercial intelligence test, the *Wechsler Preschool and Primary Scale of Intelligence* (WPPSI; Wechsler, 1989). Eight subscales were administered in order to obtain an index of children's Verbal IQ, Performance IQ, Processing Speed, and Full Scale IQ.

Processing Speed. In addition to the Processing Speed measure obtained from the WPPSI, three scales from the *Woodcock Johnson III* (WJ-III, Woodcock, McGrew, & Mather, 2007) were administered (i.e., pair cancelation, decision speed, rapid picture naming) as well as a simple motor reaction time task in order to obtain a more comprehensive evaluation of children's processing speed.

Inhibitory Control Measures. Participants completed two executive function tasks that assess inhibitory control: the Hearts and Flowers Task and the Day-Night Task. In the Hearts and Flowers Task (Davidson, Amso, Anderson, & Diamond, 2006), children were presented with a series of hearts and flowers on a computer screen. Children were instructed to press the response button on the same side as the stimulus when a heart was presented and to press the response button on the opposite side that the stimulus was presented when a flower appeared. The task consisted of 57 trials (12 heart trials, 12 flower trials, 33 mixed trials). Two scores derived from the task were utilized for the present study: Accuracy and RT for the mixed trials.

In the Day-Night Task (Gerstadt et al., 1994) children were shown a set of pictures depicting the sun or the moon. Children were asked to provide a verbal response which conflicted with the presented image. The task consisted of 16 trials (Each image was presented 8 times). Two presentation orders were created: for Order 1 the trials were randomized and for Order 2 the sequence was reversed.

Working Memory. Children's verbal WM capacity was indexed by a simple and complex word span task. In the simple word span task, children heard a series of familiar nouns (judged by the MacArthur Communicative Development Inventory; Dale & Fenson, 1996) and were asked to repeat the nouns in the same order they were presented. In the complex word span task, children were asked to repeat the items in the reverse order. The number of words given in a set increased monotonically after children correctly completed two trials within a given set size. The minimum set size was a list length of 2 words and the maximum set size was a list length of 6 words. The child's score was the largest set size he (or she) could correctly recite.

Performance-Based SSA Measures. Participants completed two performance-based SSA tasks: *Track-It* and the *Kiddie Continuous Performance Task.* The *Track-It* task (Fisher et al., 2013) was administered to obtain a performance-based measure of children's SSA. This task also provides a non-verbal WM measure. In this task, children saw several objects (e.g., simple shapes) moving across a computer screen. At the end of each trial the objects land on one of nine locations and disappear. Children were asked to watch the target object while ignoring distractors. When the objects stopped moving and disappeared from the computer screen, children were asked to identify the location last visited by the target object. After each trial, a memory-check was administered in which children were presented with an array of shapes and asked to identify the target object on the preceding trial.

The *Kiddie Continuous Performance Task* (K-CPT; Conners & Staff, 2001) was included in the assessment battery as a standard performance-based measure of SSA. In this computer task, children were presented with a series of visual stimuli (i.e., pictures). The child's task was to press a button in response to the targets and withhold a response for non-targets. Three scores derived from the K-CPT were utilized for the present study: hit rate RT, omission errors, and commission errors.

Results

Off-Task Behavior

Coding of the video data is currently in progress. Consequently, the results regarding children's off-task behavior are from a subset of the sample (n = 22), and should be considered preliminary.

Total proportion of time spent off-task was measured, and group means were compared in each condition. The overall proportion of time spent off-task was significantly greater in the HVD condition (M = 28%, SD = 22%) compared to the LVD condition (M =12%, SD = 14%), paired-sample $t(21) = 3.99$, $p = 0.001$, Cohen's $d = 0.87$. This finding suggests the experimental manipulation of the visual environment was effective in inducing lower or higher levels of SSA during the learning task.

Learning Outcomes

Pair-wise comparisons were conducted to examine children's performance on the pre-test in the HVD and LVD conditions. The analysis revealed no significant difference across conditions at pre-test ($M_{HVD} = 0.29$, $SD = 0.14$; $M_{LVD} = 0.23$, $SD = 0.16$), suggesting that the counterbalancing procedure was effective; $t(43) = -1.80$, $p = 0.08$. Additionally, the test stimuli were novel to the children as performance on the pre-test for both versions of the PAL task (*Birds* and *Monkeys/Apes* collapsed across HVD and LVD conditions) was not significantly different from chance (0.25); $M_{Birds} = 0.25$, $SD = 0.15$; $M_{Monkeys} = 0.27$, $SD = 0.16$; single sample $ts < 0.86$, $ps > 0.39$.

Learning occurred in both conditions as evidenced by children's above chance performance on the recognition subscale in both the HVD ($M_{HVD} = 0.47$, $SD = 0.25$) and LVD ($M_{LVD} = 0.49$, $SD = 0.27$) conditions; single sample $ts> 5.82$, $ps < 0.0001$. Pair-wise comparisons were conducted to examine condition differences on the PAL post-test for both recognition and recall subscales. For the recognition subscale, there was no significant effect of condition, $t(43) < 1$, *ns*; consequently, this variable was not included in subsequent analyses. However, a significant effect of condition was found for the recall subscale. Children obtained higher recall scores in the LVD condition ($M = 0.20$, $SD = 0.23$) compared to the HVD condition ($M = 0.14$, $SD = 0.18$), $t(43) = 2.12$, $p = 0.04$, Cohen's $d = 0.29$.

Are Performance-Based and Behavioral indices of SSA Related to Children's Learning?

Next, we examined the relationship between performance-based measures of SSA, the behavioral index of SSA, and children's Recall scores on the PAL task. For these analyses, we averaged children's scores on the PAL recall subscale in the HVD and LVD conditions to create a single variable 'total recall score'. Similarly the duration of time spent off-task in the HVD and LVD conditions were averaged together to create a single variable 'total time off-task'. A composite performance-based SSA variable was created which included children's accuracy on the Track-It task (i.e., the ability to accurately track where the target object disappeared) and two measures from the K-CPT: hit rate RT (i.e., the average speed of children's correct responses) and omission errors (i.e., failure to respond to the targets). The performance-based SSA composite score was created by standardizing each measure, using Z-scores, and averaging the standardized scores together.

The performance-based SSA composite variable was not found to be significantly correlated with children's 'total recall score' ($r = 0.05$, $p = 0.76$). Consequently, the performance-based SSA composite variable was not included in subsequent analyses. In contrast, the association between the behavioral index of SSA, 'total time off-task,' and 'total recall score' was marginally significant: Children who spent more time off-task tended to obtain lower recall scores, $r = -0.38$, $p = 0.08$.

Predicting Children's Learning Outcomes

Due to the page limit constraints, we are only able to explore a subset of the data in the present paper. In order to determine if SSA and the aforementioned individual difference factors were predictive of children's learning outcomes, a linear regression was performed. The dependent variable was children's 'total recall score' (i.e., average PAL recall scores across the HVD and LVD conditions). When 'total time off-task' was entered as the sole predictor of children's learning scores the model was marginally significant; $F(1, 20) = 3.34$, $p = 0.082$. In this model, total time off-task was only found to account for 14% of the variability in children's learning performance (*adjusted* R^2 = 10%). The fit of the model was enhanced when the individual difference factors were included in model 2.

Five predictors were included in model 2: (1) total time off-task, (2) Verbal IQ, (3) Processing Speed composite (WPPSI-PSQ; WJ-III: pair cancelation, decision speed, rapid picture naming; motor speed RT), (4) Working Memory composite (simple and complex word span; non-verbal WM), and (5) Inhibitory Control composite (Day-Night task, Hearts & Flowers task (accuracy and RT); K-CPT commission errors (i.e., responses to non-targets)). Composite scores for the individual difference factors were created by standardizing each measure, using Z-scores, and averaging the standardized scores together. A correlation matrix for total time off-task, total recall score, and the individual difference composite variables is provided in Table 1. Although many of the composite variables were significantly correlated with one another, concerns regarding multicollinearity were mitigated as the tolerance values were within the acceptable range (ranging from 0.455 to 0.75).

Overall, model 2 significantly predicted children's learning outcomes; $F(5,16) = 3.74$, $p = 0.02$. The model accounted for 54% of the variance in children's learning scores (*adjusted* R^2 = 39%). However, only verbal IQ was found to be significantly related to children's total recall scores: ($\beta = 0.52$, $t = 2.59$, $p = 0.02$), while processing speed was a marginally significant predictor ($\beta = -0.39$, $t = -1.94$,

p = 0.07). Critically, total time off-task was not found to be a significant predictor when individual difference measures were entered into the model (β = -0.20, t = -0.80, p = 0.43).

It is possible that certain individual difference factors may be more critical in certain types of learning environments (e.g., having good inhibitory control may be more critical in the HVD environment and thus a better predictor of learning than in the LVD condition). Therefore, in models 3 and 4 we examined the relationship between SSA, the individual difference factors, and learning within each experimental condition (i.e., LVD vs. HVD).

Table 1. Pattern of correlations between total time spent off-task, total recall scores, and the individual difference composite variables.

	2	3	4	5	6	7
1. Recall	-.378 +	.046	.581 **	-.079	.233	.395 **
2. Time Off-Task	1	.248	-.362 +	-.486 *	-.396 +	-.619 **
3. SSA Perf. Based		1	.028	-.117	-.015	-.226
4. VIQ			1	.192	.374 *	.388 **
5. Proc. Speed				1	.166	.204
6. WM					1	.378 *
7. Inhib. Control						1

Note. ** $p \leq .01$; * $p \leq .05$; + $p \leq .10$; p-values are 2-tailed.

In model 3 the dependent variable was children's LVD recall scores. Five predictors were included in the model: (1) time spent off-task in the LVD condition, (2) Verbal IQ, (3) Processing Speed composite, (4) Working Memory composite, and (5) Inhibitory Control composite. Model 3 significantly predicted children's LVD recall scores; $F(5,16) = 3.02$, p = 0.04. The model accounted for 49% of the variance in children's learning scores (*adjusted* R^2 = 32%; Tolerance values ranged from 0.56 to 0.78). Processing speed was significantly related to children's LVD recall scores (β = -0.45, t = -2.21, p = 0.04). Verbal IQ was a marginally a significant predictor: (β = 0.42, t = 1.98, p = .06) as was inhibitory control (β = 0.37, t = 1.68, p = 0.11). No other individual difference factors were significant.

In model 4 the dependent variable was children's HVD recall scores. Five predictors were included in the model: (1) time spent off-task in the HVD condition, (2) Verbal IQ, (3) Processing Speed composite, (4) Working Memory composite, and (5) Inhibitory Control composite. Overall, model 4 was marginally significant in predicting children's HVD recall scores; $F(5,16) = 2.70$, p = 0.059. The model accounted for 46% of the variance in children's learning scores (*adjusted* R^2 = 29%; Tolerance values ranged from 0.49 to 0.84). However, only Verbal IQ was found to be significantly related to children's HVD recall scores: (β = 0.54, t = 2.47, p = 0.02).

The present findings suggest that some individual difference factors, such as IQ, may be a more consistent predictor of children's learning outcomes across different types of learning environments; while the influence of other individual difference factors (e.g., processing speed) may only be elevated in certain types of learning environments.

Discussion

The results from the present study indicate that the visual environment can in principle impact children's attention allocation as evidenced by the increase in children's off-task behavior in the HVD condition compared to the LVD condition. Additionally, changes in attention allocation were related to changes in children's learning outcomes. Specifically, children's recall scores on the PAL task were significantly higher in the LVD condition compared to the HVD condition suggesting that SSA (indexed by the proportion of time spent off-task) is related to children's learning. Indeed, when total time off-task was entered as the sole predictor of children's total recall scores the model was marginally significant and time off-task accounted for 14% of the variability in children's learning performance. However, a more predictive model was obtained when individual difference factors were included in the model: The model which included time off-task and the individual difference measures accounted for 54% of the variability in children's learning performance. Importantly, once the individual difference factors were incorporated into the model, time off-task was no longer a significant predictor.

The present findings tentatively suggest that increasing learning is not as simple as increasing time on-task. Despite the intuitive appeal of this belief, time off-task was not found to be a strong predictor of children's learning performance. Conceivably the effect of time on learning may be modulated by pertinent individual difference factors. Thus, time off-task may only be a critical factor for children for whom the allotted time is insufficient due to a variety of individual difference factors (e.g., children who have a low IQ, slow information processing speed, weak inhibitory control, etc.). However it is important to keep in mind that these findings are based on time off-task data obtained from a subset of the sample. It remains to be determined if the preliminary pattern of results will persist once the time off-task data has been coded for the entire sample.

This line of research has the potential to make several important contributions to the field. First, the present experiment employed a within-subject experimental manipulation in which lower or higher levels of SSA were induced by introducing or removing visual displays during a learning task. Utilizing a within-subject experimental design allows inferences to be made regarding causality and thus improves upon prior work which was largely correlational.

Second, this study helps to address methodological concerns that limit the generalizability of previous work, which correlated SSA to distant measures of achievement or task performance rather than learning per se. In contrast, this study links SSA to immediate measures of genuine learning. Critically, the learning task utilized in the present study is a more naturalistic learning task in which children learn to pair a novel label (i.e., animal name) with the corresponding picture. The PAL task utilizes valid science content; the labels and animals that children learn about during the task are factual. These modifications allow for a more rigorous examination of the relationship between SSA and learning and it provides a foundation to more fully explore whether the previous findings pertaining to the relationship between SSA and task performance can be extended to learning outcomes as well.

Considerable variability in the correlation strength between SSA, achievement, and task performance has been documented in the prior literature. These divergent results highlight the importance of investigating the role of individual differences. The present work begins to addresses this issue directly by collecting measures of IQ, WM, processing speed, and inhibitory control which will ultimately help create a better understanding of the factors that influence the relationship between SSA and learning. Upon completion of the video coding of children's off-task behavior, additional analyses will be conducted which will allow a formal test of the hypothesis that the individual difference factors discussed here mediate or moderate the relationship between SSA and learning. Collectively, this work will help foster a more nuanced understanding of the relationship between SSA and learning.

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References

Caldwell, J.H., Huitt, W.G., & Graeber, A.O. (1982). Time spent in learning: Implications from research. *The Elementary School Journal*, 82, 470-480.

Checa, P. & Rueda, M. R. (2011). Behavioral and brain measures of executive attention and school competence in late childhood. *Developmental Neuropsychology,* 36(8), 1018-1032.

Choudhury, N. & Gorman, K. S. (2000). The relationship between sustained attention and cognitive performance in 17-24 month old toddlers. *Infant and Child Development*, 9, 127-146.

Cohen, J. (1960). A coefficient of agreement for nominal scales. *Educational and Psychological Measurement*, 20, 37–46.

Conners, C. K. & Staff, M. (2001). Conners' Kiddie Continuous Performance Test (K-CPT): Computer Program for Windows Technical Guide and Software Manual. Toronto, ON: MHS.

Dale, P.S., & Fenson, L. (1996). Lexical development norms for young children. Behavior Research Methods, Instruments, & Computers, 28, 125-127.

Davidson, M. C., Amso, D., Anderson, L.C. & Diamond, A. (2006), Development of cognitive control and executive functions from 4 to 13 years: Evidence from manipulations of memory, inhibition, and task switching. *Neuropsychologia*, 44(11), 2037–2078.

Duncan, G. J., Dowsett, C. J., Claessens, A., Magnuson, K., Huston, A. C., Klebanov, P., Pagani, L.S., Feinstein, L., Engel, M., Brooks-Gunn, J., Sexton, H., Duckworth, K., & Japel, C. (2007). School readiness and later achievement. *Developmental Psychology,* 43(6), 1428-1446.

Fisher, A. V., Thiessen, E., Godwin, K., Kloos, H., & Dickerson, J. P. (2013). Mechanisms of focused attention in 3- to 5-year-old children: Evidence from a new object tracking task. *Journal of Experimental Child Psychology,* 114(2), 275-294.

Fleiss, J.L. (1981). *Statistical methods for rates and proportions* (2nd ed.). New York: John Wiley.

Frederick, W. C., & Walberg, H. J. (1980). Learning as a function of time. *Journal of Educational Research, 73,* 183-194.

Gerstadt, C., Hong, Y., & Diamond, A. (1994). The relationship between cognition and action: Performance of 3½-7 year old children on a Stroop-like day–night test. *Cognition*, 53, 129–153.

Henderson, J., & Ferreira, F. (2004). *In The interface of language, vision, and action: Eye movements and the visual world*. New York, NY: Taylor & Francis.

Higgins, A. T., & Turnure, J. E. (1984). Distractibility and concentration of attention in children's development. *Child Development,* 55(5), 1799-1810.

Just, M., and Carpenter, P. (1976). Eye fixations and cognitive processes. *Cognitive Psychology*, 8, 441–480.

Lehman, E. B., Naglieri, J. A., & Aquilino, S. A. (2010). A national study on the development of visual attention using the cognitive assessment system. *Journal of Attention Disorders,* 14, 15-24.

Woodcock, R. W., McGrew, K. S., & Mather, N. (2007) *Woodcock Johnson III* (WJ-III). Riverside Publishing.

Reid, R. & Harris, K. R. (1993). Self-monitoring of attention versus self-monitoring of performance: Effects on attention and academic performance. *Exceptional Children,* 60(1), 29 - 40.

Setliff, A. E., & Courage, M. L. (2011). Background television and infants allocation of their attention during toy play. *Infancy*, 16(6), 611-639.

Schweizer, K. & Moosbrugger, H. (2004). Attention and working memory as predictors of intelligence. *Intelligence,* 329-347.

Wechsler, D. (1989). Wechsler Preschool and Primary Scale of Intelligence - Revised. San Antonio, TX: The Psychological Corporation.