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An In Depth Analyses of Specific Language Impairment as Compared to Other Developmental Disorders

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AN IN DEPTH ANALYSES OF SPECIFIC LANGUAGE IMPAIRMENT AS COMPARED TO OTHER DEVELOPMENTAL DISORDERS

By

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Abstract

Specific language impairment (SLI), defined as a disproportionate difficulty in learning language despite having normal hearing, intelligence, and no known neurological or emotional impairment, has been shown to share similar cognitive characteristics with individuals with attention deficit hyperactive disorder (ADHD). However, little research has investigated the dissimilarities in these two different developmental disorders. Children with SLI also show many similar symptoms with individuals diagnosed with dyslexia. The aim of these studies is to get a better understanding of cognitive differences between SLI and ADHD, and the cognitive similarities between SLI and dyslexia. Tests of both verbal and non-verbal measures of working memory, IQ, and academic performance were administered to all groups. It was hypothesized that children with SLI would perform worse on verbal measures due to their language deficits but perform better on non-verbal measures than children with ADHD. It was also predicted that children with SLI would perform similarly, but worse than children with dyslexia. Results from the SLI/ADHD experiment confirm this pattern: children with SLI performed poorer than children with ADHD on all verbal cognitive measures. When looking at the non-verbal measures of abilities, the SLI group outperformed the ADHD group on working memory and IQ scores but not academic performance scores. Results from the SLI/Dyslexia experiment also confirmed what was predicted. Children with dyslexia outperformed their SLI counterparts on all cognitive measures. A possible explanation for these findings is that there are fewer classroom-based programs designed specifically to support children with SLI.

Introduction

The average child will say their first word when they are around one year old, but this is only the average child. Around 7% of children will take twice as long. As they get older they will continue to develop worsening language problems. Some will have trouble understanding words spoken to them or struggle to produce the desired words themselves. These children fit the profile for a diagnosis of specific language impairment, or SLI. SLI is a language impairment characterized by a disproportionate difficulty in learning language despite having normal hearing, intelligence, and no known neurological or emotional impairment (Alloway, Rajendran, & Archibald, 2009). There are still many mysteries that surround SLI, most notably of them being what causes SLI, and to this point, no research has found a direct cause for SLI. Studies performed on children with SLI have shown though that SLI is a disorder that affects people from the same family. This points to a genetic link but since families usually share the same environment, it makes the genetic theory difficult to prove. However, twin studies performed on genetically identical monozygotic twins versus dizygotic have further confirmed the genetic theory by showing that environment plays a little role if any on the acquiring of SLI (Bishop, 2006). Other research has also identified that there is a high rate of heritability in SLI and because the environment does not play a role in the development of SLI, this research further supports the belief that SLI is caused by genetics.

Once research came to the conclusion that SLI was indeed the byproduct of faulty genes, the goal of SLI research shifted to trying to identify the specific gene that causes the production of language. It is the belief of researchers that SLI is caused by a defection of this gene and that identifying this gene would not only allow for a medical way to test for SLI, but also identify the gene that separates human language abilities from animals (Bishop, 2006). So far, this gene has still not been identified, however, genetic research still continues on SLI. New research has shown that genetic mutations on chromosome 6 have been linked to not only SLI, but other developmental disabilities such as dyslexia and autism (Specific Language Impairment, 2013). Although research seems to be getting close to identifying the specific gene, if there is one, that causes SLI, there still has not been a specific cause associated with SLI.

Genetic research is only one kind of research done into learning more about SLI. Another type of research being conducted on SLI is called bilingual research. Bilingual research is research targeted at children who speak more than one language who may be thought to have SLI. Due to the fact that all standardized tests for language impairments are in English, many children who are learning English as a second language will score in the language impairment range for native English speaking children. Bilingual research aims to develop ways to identify SLI in children who do not speak English as a first language as well as separate bilingual children who have language disabilities from bilingual children who are only having a hard time with their new language. Because of bilingual research, tests have been designed to test for SLI in children who speak in languages other than English (Specific Language Impairment, 2013).

Additional research being conducted on SLI is diagnostic research, which attempts to find ways to better diagnose SLI by distinguishing SLI from other language impairments and developmental disabilities. As a result of SLI sharing many symptoms with other developmental disorders such as autism and dyslexia, diagnostic research must comb through all the related symptoms to find the ones that are unique to SLI. By identifying symptoms unique to SLI, diagnosis of SLI will become a much simpler task. Diagnostic research is attempting this by examining data collected by studying behaviors, eye-tracking tasks, neurophysiological data, and other general measures of development (Specific Language Impairment, 2013). This research allows for a greater understanding as to how SLI differs with regards to other similar developmental disorders.

Although much research has gone into showing how SLI differs from certain other developmental disorders that show similar symptoms, such as dyslexia, SLI has also been shown to be linked in various ways to other developmental disabilities. One developmental disorder that SLI has been shown to be strongly linked to is attention deficit hyperactivity disorder (ADHD). ADHD is the most common psychiatric disorder in children and is characterized by inattentiveness, hyperactivity, and impulsivity (Ho, 2011). ADHD is also one of the most common psychiatric disorder when already diagnosed with SLI. Despite this frequent co-occurrence however, little research has been done into the commonalities in both disorders.

Research relating to the endophenotypes of these disorders suggests that they are two diverse conditions. Sustained attention, response control, and incentives have all been shown to be endophenotypes of ADHD (Uebel, 2010), whereas endophenotypes for SLI include poor nonword repetition and possibly a compromised ability to identify tone sequences (Bishop, 2006). Despite differing underlying factors responsible for the disorders, children with ADHD may show many similar signs with their SLI counterparts.

Another developmental disorder that shares many similar symptoms with SLI is dyslexia, a widely known developmental language impairment that is characterized by slow and inaccurate word recognition (Robin & Bruce, 2007). New research findings have linked dyslexia to other developmental language disorders, one being SLI (Benítez-Burraco). Dyslexia and SLI are both common childhood disorders that show noteworthy overlaps in symptoms and have even been suggested to be biologically linked to one another (Newbury et al., 2011).

Children diagnosed with either dyslexia or SLI will face similar challenges, but where these conditions differ is in their presentation of symptoms. This however is what would be expected to be seen if these conditions only differ on severity. Research shows that children with either condition will show an equally impaired ability in memory tasks, but children with SLI are at a greater disadvantage in verbal skills. This is due to a phonological processing system that is more compromised than the dyslexia counterparts (Nithart et al., 2009). Research has also shown that children with SLI are also at a greater disadvantage when it comes to measures of short-term working memory (Nithart et al., 2009). The differences in these conditions actually show how dyslexia and SLI are closely related conditions that differ in the size of the effect they have.

A similar feature that all these disorders share is poor academic performance. Two factors that have been shown to directly contribute to grade performance are IQ and working memory. Working memory, defined as our ability to store and manipulate information, can predict scores in reasoning tasks and verbal comprehension (Alloway, Rajendran, & Archibald, 2009). Although most schools today still rely on only IQ scores and not working memory scores to gauge academic ability (Duckworth, Quinn, & Tsukayama, 2012), longitudinal research on working memory and IQ has demonstrated that the former makes a key contribution to subsequent academic success (Alloway & Alloway, 2010). Recent research has also shown that the two scores actually share very little in common with each other (Alloway, 2009).

The aim of the SLI/ADHD and the SLI/Dyslexiaexperiments are to get a better understanding of SLI as it relates to other developmental disorders as they relate to two key cognitive skills linked to learning—IQ and working memory. In the SLI/ADHD experiment, this will be done by studying ADHD and SLI as distinct disorders. Although there has been much research examining ADHD and its comorbidity with language impairment, little research has been conducted comparing the two conditions as occurring independently. When looking at ADHD and SLI side by side, certain strengths and weaknesses are observable. For example, in verbal abilities, children with ADHD perform better than children with SLI due to the lack of a language deficit in children with only ADHD. However, children with ADHD tend to perform poorer on visuo, non-verbal tasks than children with SLI (Sergeant, Piek, & Oosterlaan, 2005). A key benefit of looking at ADHD and SLI side by side is that further information can be gained on how they differ.

The intention of the SLI/Dyslexia experiment, counter to the SLI/ADHD experiment, is to examine if dyslexia and SLI are in fact the same developmental disorders that differ only by their severity. Although new research has started identifying these two conditions as being closely related, the research so far has only gone so far as to state that the two conditions are only caused by the same underlying problem (Bishop & Snowling, 2004). This experiment will show that these two conditions share significantly more in common than just their endophenotypes.

Method

Participants

SLI: The SLI group was made up of 40 children aged between 7 and 15 with a clinical diagnosis of specific language impairment. The SLI children were recruited from language units in England. The mean age of the participants was 9 years 10 months (SD=2.09 months). There were 35 boys and 5 girls in this sample. None of the children were diagnosed with ADD/ADHD or hearing impairments.

Dyslexia: The dyslexia group consisted of 72 children with a mean age of 11 years 8 months (SD=2.71) with a clinical diagnosis of dyslexia. All children were assessed by an educational psychologist on standardized test and reading scores were below age-expected levels, indicating dyslexia.

ADHD: The ADHD group consisted of 83 children between 8 and 11 years old. These children were recruited through pediatric psychiatrists and community pediatricians based in the North-East of England. The mean age of the ADHD group was 9 years 9 months (*SD*=11.98 months), and there were 71 boys and 12 girls. The majority were receiving psycho stimulant medication for ADHD (methylphenidate *n*=64, dexamphetamine *n*=2, dexedrine *n*=2, imipramine *n*=1) and 15 were receiving no medication. Children prescribed drugs for their ADHD symptoms ceased ingestion 24 hours prior to testing. No children with Autistic Spectrum Disorders were included in the sample.

Control: A comparison group of 50 typically developing, non-ADHD children aged between 8 and 11 years from the same schools was also recruited, with a mean chronological age of 9 years 10 months (SD = 11.89 months).This group consisted of 20 girls and 30 boys.

None of these students were identified with a learning disorder or were receiving special support at school. Consent was obtained from all participating parents/guardians and children from all groups, with appropriate opportunities for withdrawal.

Materials and Procedure

Participants completed six different tests measuring both verbal and non-verbal aptitude in working memory, IQ, and academic abilities. Working memory was tested using the Processing Letter Recall and Mr. X test to measure verbal and visuo-spatial working memory respectively. These standardized tests were taken from the Alloway Working Memory Assessment (2012). In the Mr. X test, participants first determined whether Mr. Blue held a ball in the same hand as Mr. Red. Then they had to identify the location of Mr. Blue's ball/s on the computer screen. In the processing letter recall test, participants heard a letter and then had to identify whether a new letter shown on the computer screen matched the letter they heard. They then had to recall the letter/s presented auditorily in the correct order. Verbal and non-verbal IQ was indexed with the vocabulary and matrix tests, respectively, from the Wechsler Abbreviated Scale of Intelligence (WASI, Wechsler, 1999). Academic performance was assessed with arithmetic and spelling tests Wechsler Individual Achievement Test-Revised (WIAT-II, Wechsler, 2001). Children were tested individually with a trained researcher, in a quiet classroom at school.

Results and Discussion

Experiment 1 (SLI/ADHD):

Table 1. Descriptive statistics for all cognitive tests as a function of group

Table 1.

Measures	SLI	ADHD	AWM
	M (SD)	M (SD)	M (SD)
Verbal Working Memory	87.65(7.62)	90.65(17.70)	102.76(10.84)
Visuo-spatial Working Memory	95.93(17.09)	85.84(14.68)	102.90(19.25)
VerbalIQ: Vocabulary	38.37(8.78)	38.52(10.60)	47.24(10.92)
Non-verbalIQ: Matrix	46.10(10.66)	41.00(9.52)	47.50(9.25)
Academic: Spelling	75.75(8.99)	86.75(14.41)	100.12(12.41)
Academic: Arithmetic	82.83(9.63)	83.93(13.84)	95.62(8.57)

Multiple MANOVAs were performed on the standard scores of the different cognitive skills (Table 1). The first MANOVA was performed on the standard scores of working memory tests. The overall group term associated with Hotelling’s T-test indicated a significant difference between groups: F=13.92, $p<.001$; $\eta 2p=.14$.Post-hoc comparison (Bonferroni adjustment for multiple comparisons, $p<.05$) showed the following patterns. In verbal working memory, the Control group scored significantly higher than both the SLI and ADHD groups. In visuo-spatial working memory, both the Control and SLI groups performed better than the ADHD group.

The next MANOVA was performed on the standard scores of IQ tests. The group term for IQ associated with Hotelling's T-test showed a significant difference between groups:

F=8.86, p<.001; η2p=.09.Post-hoc comparison (Bonferroni adjustment for multiple comparisons, p<.05) showed the following patterns. For measures on vocabulary, both the SLI and ADHD groups scored significantly lower than the Control group. In the Matrix test, the ADHD group performed worse than Control and SLI groups.

The last MANOVA was performed on the standard scores of the academic tests. The overall group term associated with Hotelling's T-test was significant: *F*=23.16, pb.001; η2p=.22.Post-hoc pairwise comparisons found significant differences in the following (p<.001, Bonferroni adjustment for multiple comparisons, see Table 1).Children in the Control group scored higher on both spelling and arithmetic measures. However, the SLI group also scored significantly lower than the ADHD group in Spelling.

There were several key patterns observed in the present experiment. As predicted, the Control group outperformed the other groups on all cognitive tests. Looking first at the verbal tests, although as a group the ADHD children outperformed the SLI group on all verbal measures, their performance was only significantly higher than the SLI children in the spelling test. This could be due to the symptoms of SLI being more evident in an academic setting. In a classroom setting, children are expected to be on a similar academic level to their peers. When this is not the case and a child is unable to work on the same level as his or her peers, such as a child with SLI, the child will become frustrated and stressed, further contributing to poor academic abilities.

When looking at non-verbal cognitive measures, the SLI group significantly outperformed the ADHD group in visuo-spatial working memory and the matrix IQ test. The weak non-verbal performance of the ADHD children are in line with research indicating that

ADHD is closely related with non-verbal learning disorders (Scherer), even to the extent of non-verbal learning disorders being misdiagnosed as ADHD. Since SLI primarily compromises a child's capacity to communicate and effectively use language, it is likely that they would not exhibit a non-verbal deficit. The pattern of results fit this idea as the SLI group performed similarly to the control group in non-verbal cognitive tests.

It was interesting that despite average non-verbal performance in tests of IQ and working memory, the SLI group still performed below average in both academic tests. One explanation for why their performance was impaired could be due to a lack of awareness of different learning disorders. This is most likely due to the way in which school classes are taught mixed with the known prevalence of these conditions. ADHD is the most commonly over diagnosed, and probably the most well known psychological condition. School teachers and administrators who may not know about SLI will identify at least the prominent features of ADHD. For this reason, teachers could tailor their teaching styles in a way that fosters academic abilities in both typically developing children, and children with ADHD with no language deficiencies. Children with SLI, who very often are acting out in class because of their lack of abilities, will probably be incorrectly grouped with children with ADHD. Classes that may help children with ADHD progress, more than likely, will not help children with SLI, meaning that the problem is not their academic abilities that are weaker than that of a child with ADHD, but that their learning style is not conducive for a child with SLI.

Future research could include a new group of children with co-morbid ADHD and SLI. Comparing children with only ADHD or SLI to both co-morbid groups and typically developing children would allow for greater insight into the types of behaviors linked to classroom performance. Future research could also extend such investigations to cross-cultural comparisons. Recent research on children from Russia living in the U.S. has shown a large number of developmental disorder cases (Beverly, McGuinness, & Blanton, 2008). By not only selecting participants from western nations such as England and the U.S., but also eastern cultures such as China and Russia further insight into developmental disorders and their affect on academic performance.

In summary, this experiment adds to existing research by examining in what aspects ADHD and SLI differ specifically. This experiment also shows that despite an advantage in non-verbal abilities over children with ADHD, in the classroom environment, children with SLI are specifically impaired. The present experiment shows evidence that the use of specialized interventions and classes designed to improve the academic performance of children with SLI could aid in raising scores to that of at least other non-typically developing children.

Experiment 2 (SLI/Dyslexia):

Table 2. Stepwise regression analyses predicting academic performance

Dependent		Independent	*R2*	*ΔR2*	*df*	*ΔF*	*B*	*t*
Spelling (Dyslexia)	1	Matrix	.207	.207	1, 57	14.85*	.51	4.35*
	2	Mr X	.269	.063	1,56	4.79	.26	-2.19
Spelling (SLI)	1	Vocabulary	.130	.130	1, 37	5.524*	.36	2.35*
Math (Dyslexia)	1	Vocabulary	.286	.286	1, 57	22.87*	.36	2.86*
	2	Matrix	.370	.083	1, 56	7.41*	.34	2.72*
Math (SLI)	1	Matrix	.182	.182	1, 37	8.23*	.43	2.87*

Note: *$p<.02$

Multiple MANOVAs were performed on the standard scores of the different cognitive skills (Table 2). The first MANOVA was performed on working memory tests. The overall group term associated with Hotelling's T-test indicated a significant difference between groups: $F=26.53$, $p<.001$; $\eta 2p=.358$. Post-hoc comparison ($p<.05$) showed that the dyslexic group performed significantly better than the SLI group on both working memory measures.

The next MANOVA was performed on the standard scores of IQ tests. The group term for IQ associated with Hotelling's T-test showed a significant difference between groups: $F=3.12$, $p<.05$; $\eta 2p=.05$. Post-hoc comparison ($p<.05$) showed the dyslexia group outperformed the SLI group on both IQ measures but only performed significantly better on the vocabulary test.

The last MANOVA was performed on the standard scores of the academic tests. The overall group term associated with Hotelling's T-test was significant: $F=16.76$, $p<.001$; $\eta 2p=.24$. Post-hoc pairwise comparisons found significant differences in the following ($p<.05$). The dyslexia group again significantly outperformed the SLI group on both measures of academic performance.

In order to identify the best predictive variables of academic performance (spelling and math), a series of stepwise regression analyses were conducted. Standard scores of four cognitive tests (working memory & IQ) were entered simultaneously with a stepwise function. Model statistics, as well as standardized beta values, and t-statistics, are provided in Table 2.

For spelling in the Dyslexia sample, both the Matrix test and the Mr X test accounted for significant proportion of unique variance: Matrix (20.7%) and Mr X (6%). For the SLI sample, Vocabulary accounted for significant proportion of unique variance (13%).

In math, there were differential predictors for the groups. For the ADHD students, both Vocabulary (34.2%) and visuo-spatial working memory (6.5%) accounted for significant proportion of unique variance. For the SLI students, only the Matrix test (20%) significantly predicted math performance.

The results of this experiment show great similarities between dyslexia and SLI on several cognitive measures. The dyslexia group, as predicted, did score higher than the SLI group on all cognitive tests, however the dyslexia group did not always score significantly higher. When looking at non-verbal abilities, the results show that the dyslexia group and SLI group scored reasonably close to each other. This is most likely due to the fact that both dyslexia and SLI are disorders that mainly affect verbal abilities. This is further proven by the dyslexia group significantly outperforming the SLI group on all measures of verbal abilities.

When looking at academic achievement, the results show differential links between working memory and IQ on how they affect academic performance. For spelling, the dyslexia group rely more on non-verbal abilities, as shown by both the matrix and Mr. X tests, whereas the SLI group's academic performance relied on their compromised verbal abilities. For math, the dyslexia group relies on both verbal and non-verbal abilities, but again the SLI group only relies on verbal abilities. It may be for this reason that the symptoms of SLI appear more severe than those of dyslexia.

What distinguished these two developmental disorders is in fact not their severity of symptoms as anticipated, but which cognitive skills are employed. While children diagnosed with dyslexia rely less on their compromised verbal abilities and more on their normal non-verbal abilities, children diagnosed with SLI rely solely on their weakened verbal abilities. Programs designed to teach children with SLI ways of utilizing more non-verbal abilities would have the potential to see the differences in severity of these two conditions diminish.

Conclusion

Based on the results of the two experiments, a pattern of SLI children being especially compromised in a school setting is observed. Although many schools have programs in place to help improve the academic abilities of children with certain developmental disorders, many schools are lacking the resources necessary to help children with SLI. However, some schools do have programs set in place that aim to instruct teachers on better ways to help children with SLI. These programs emphasize that teachers become informed about SLI, collaborate with parents of children with SLI, and to be patient and mindful of the special attention children with SLI require (Hamilton). Teachers are also encouraged to make adjustments in the classroom that are beneficial to children with SLI. An example of this would be teachers utilizing more visual aids to help explain concepts since visual aids are less taxing on SLI children's compromised verbal abilities. Despite that these programs do exist in some schools, general education's ability to help children with SLI is still far from perfect.

Although these two experiments accomplish their goals in two entirely different ways, one attempting to show differences with other developmental disorders and the other showing their similarities, both of these experiments indeed accomplish the overlying goal of bettering the understanding of SLI. The SLI/ADHD experiment shows that despite obvious weaknesses in verbal abilities versus non-language impaired disorders, children with SLI show almost normal abilities in non-verbal tasks especially when compared to ADHD, a non-language impaired disorder. The SLI/ADHD experiment also shows that these non-verbal abilities do not transfer over to school based academic abilities implying that the problem lies not with the children with SLI, but the ways in which they are taught. The SLI/Dyslexia experiment furthers the research on SLI by showing that despite large similarities to dyslexia, language impairment, the two are only related by symptoms and that children with SLI employ different cognitive skills than do children with dyslexia. The SLI/Dyslexia experiment also shows a similarity in non-verbal abilities possibly signifying that many language impairments mostly differ on the severity of effect on verbal abilities as well as which cognitive abilities are utilized the most. Again in the SLI/Dyslexia experiment, just as with the SLI/ADHD experiment, a lack of academic abilities are noted in both verbal and non-verbal categories, further proving the point that new intervention programs must be put in place in order to give children with SLI and other language impairments the ability to maximize the academic potential.

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Vita

Adam Stein was born , but was raised in . He was raised by his parents Dr. Wayne Stein, a licensed psychologist, and Barbara Stein, a registered psychological nurse. He attended Cocoa Beach Jr./Sr. High School in Cocoa Beach, Florida, until graduating

In 2007, he attended the University of South Florida in Tampa, but transferred to the University of Central Florida in Orlando in 2008 after his freshman year. He remained there until graduating with a Bachelor of Science in Psychology in 2011.

In 2011, he began his Master's of Arts in General Psychology at the University of North Florida in Jacksonville. While at the University of North Florida, Adam presented his research at the Showcase of Osprey's Advancement in Research and Scholarship (SOARS) conference in 2013. Currently, Adam is receiving his teacher's certification to begin teaching psychology classes at Eastern Florida State College in Melbourne, Florida.