STRATEGY USE AND PERFORMANCE ON WORD LEARNING TASKS

By

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Abstract

Purpose: We explored performance across time in a word-learning task for second grade children.

Method: Our participants included 107 children: 48 typically developing monolinguals, 30 typically developing bilinguals, 14 dyslexic only, four with language impairment, and 11 with comorbid dyslexia and language impairment. After meeting inclusionary criteria, children participated in six session of pirate-themed games. This study focused on one aspect of the word-learning game, the phonological-visual linking task. We compared participants' average scores across each session to explore the possibilities of distinctive patterns of learning, perseverance, or boredom shown across time.

Results: Cluster analysis revealed five different clusters of performance. The largest cluster, Group 5, contained the largest percentage of children from each category, except the language impairment category. Group 5 performed the best and showed improvement over time. Group 1 was the worst group, starting with fair accuracy and gradually becoming less accurate over time. Group 1 consisted of a fairly even percentage of children from each category.

Conclusion: Impaired children and typically developing children are both capable of increased learning across time in this phonological-visual linking task, and children with impairments are not at significantly greater risk than peers for boredom effects.

Introduction

The goal of this study was to learn about children's word learning performance across time and how it may be affected by the use of untaught strategies. This is important because different performance patterns tell us how well or how much children learn, or do not learn, from experience. For example, the first time someone goes shopping at a grocery store will probably not be their most efficient shopping trip. They may backtrack across the store, retrieving items from aisles they have already passed. In later shopping trips, they will probably learn where items in the store are located and re-organize the order in which they select items, thus learning from experience. Humans learn from experience every day without even realizing it. Performance patterns are important because they can potentially show us differences in the way experience affects learning for different children. Experience usually aids in learning, but this might not be the case for all groups of children. For example, children with learning disabilities might not benefit as much from experience as typically developing peers. Alternatively, there may be other factors that affect strategy use across children (e.g., attention, nonverbal intelligence) that are more important than diagnosis. This study will provide insight on the use of strategies across time, which is an aspect of learning. The strategies we are referring to are self-taught strategies, in which children are not provided with formal instructions on how to succeed at the task. Rather, they must learn from experience, much like the grocery store example given above.

We are particularly interested in strategy use in three groups of children: those with typical development, those with language impairment, and those with dyslexia. Language impairment (LI), historically referred to as specific language impairment (Reilly et al., 2014), is a

language acquisition and use impairment that cannot be explained due to another disorder like hearing loss (Bishop, 1992). Children with LI show difficulties with phonology, articulation, planning, speech discrimination and speech perception (Coady & Evans, 2008), and importantly for this study, word learning (Kan & Windsor, 2010). Dyslexia is a neurological learning impairment that hinders language related to phonology including word recognition, spelling, and decoding (IDA, 2012). Children with dyslexia have demonstrated deficits in oral word learning (Alt et al., 2017), so it is important to understand their learning profiles, as well.

Boredom

There has not been a significant amount of research done on performance of the same individuals on a single language task across time. However, there are a few studies of performance on other tasks to give us some idea of what to expect. Although we do expect to improve across time with strategy use, there is also the possibility that performance could decline as a result of boredom. Pekrun, Goetz, Hall, and Perry(2014) found that boredom negatively affects performance. In a study of 424 college students, boredom and performance were measured by five assessments of structural equation modeling throughout a university course that lasted for a year. They found that boredom and performance reciprocally affected each other. People did not perform as well when they were bored, and performed better when they were not bored. This study provides evidence of the link between boredom and performance that we might see in children, both those with and without impairments.

Mello, Roger, and Grasser (2007) studied the affective states, including boredom, of 28 college students while they participated in an online tutoring program for computer literacy.

The college students watched a video of their own facial expressions to judge if their affective state was boredom, flow, confusion, frustration, delight, or surprise during interaction with the online tutoring program. The researchers found that once the students became bored, they remained in this affective state until transitioning to frustration. Boredom was also found to be negatively correlated with learning (Craig et al., 2004). Once a learner enters the boredom state, they are more likely to continue in this cycle, which negatively affects their learning.

Learning in Children with Language Impairment

In order to understand what learning across time might look like for children with language impairment, it would be helpful to understand their learning in other contexts. Henry, Messer, and Nash (2011) examined performance on executive function tasks in 160 children between the ages of three and six. Forty-one were children with language impairment, 31 were children with low language functioning, and 88 were typically developing children. Ten different measures of executive functioning were assessed and group performance differences were examined after controlling for age, nonverbal IQ, and verbal abilities. The executive function tasks used included executive-loaded working memory, fluency, inhibition, planning, and switching. Henry et al. (2011) found that children with language impairment showed difficulties on several different executive function tasks. These tasks relate to word-learning tasks because children use executive function skills to perform word learning tasks. For example, children need to use working memory to remember the monster's names for efficient retrieval during the task. This study is relevant because it shows that children with language impairment perform worse than typically developing children on executive function tasks, creating an additional challenge for them during word learning. However, we do not know how this would

affect performance across time. If something is more difficult for you, you might respond by trying even harder to improve, or you might feel defeated and give up. Difficult tasks affect people in different ways.

Finneran, Francis, and Leonard (2009) assessed sustained attention with a continuous visual performance task in 13 children between four and six years of age with language impairment and 13 typically developing children. All of the children had normal vision, hearing, and attention. The researchers analyzed accuracy and response time. Children with language impairment were found to perform significantly less accurately than typically developing children, but were not significantly slower. This study concluded that children with language impairment have a smaller capacity for sustained attention. This is important to note in our study because this lack of sustained attention could either explain why a child with language impairment performs consistently poorly, or might have a performance decrease. Attention and boredom are related because as noted above, poor attention could lead to boredom, and boredom could lead to poor performance.

Strategy Use

Alt and Spaulding (2011) examined the use of an untaught vocal rehearsal strategy on a word learning task for 40 school-aged children. Half of the children had a language impairment and half of the children were typically developing. The researchers found that both groups of children used a vocal rehearsal strategy. However, this strategy only helped the typically developing children perform better on the word learning task. This shows that strategy use affects children's performance differently depending on the presence of an impairment

because the impaired children did not perform as well as the typically developing children using the same strategy. The typically developing children who used the vocal rehearsal strategy performed better with this strategy. This shows that strategies used by typically developing may lead them to better performance and increased learning.

However, researchers have found that when children begin to use new strategies, the strategies do not immediately help them become more efficient and more effective (e.g., Bjorklund & Coyle, 1995; Bjorklund et al., 1997; Miller & Seier, 1994; Miller, 1990). The reason for this could be because using a newly taught strategy uses cognitive space, which depletes the cognitive resources available for doing the actual task (Bjorklund et al., 1997; Miller & Seier, 1994). In our study, we expect children to have increased performance due to self-taught strategy used. If the children in our study were explicitly taught a strategy, then our prediction on performance across time might have been different due to the depletion of cognitive resources when taught strategies are introduced. Children would benefit from regulating their strategies and figuring out what strategy is the most helpful with what task.

Learning in Children with Dyslexia

These data reported above may help us make predictions for children with typical development and those with language learning impairments, but what about children with dyslexia? One of the most prominent problems for people with this diagnosis is difficulty with literacy and automated reading. People with dyslexia perform poorly during tasks requiring speed or with tasks that combine more than one action. (Stanovich, 1988a; Wimmer, 1993). To our knowledge, there are no data that directly address strategy use or learning over time in

people with dyslexia. However, these documented cognitive and learning deficits that children with dyslexia have give us reason to predict that they will be unlikely to show evidence of improved learning over time as a result of the use of untaught strategies.

Predictions

Our prediction is that there will be five different patterns in performance across time, including: 1. Improved performance across time (demonstrating learning from experience) 2) Improved performance followed by a decrease in performance (demonstrating learning from experience coupled with a boredom effect) 3) Consistent performance (demonstrating no learning from experience and no boredom) 4) Decreased performance (demonstrating a boredom or frustration effect) 5) No clear pattern (demonstrating the effect of other factors). We expect these patterns to be differentially distributed across the diagnosis groups. Specifically, we expect a larger percentage of children from the impaired groups to demonstrate patterns three or four than children in the typical group due to their documented challenges with learning.

The knowledge of children's learning performance across time can be applied in many different settings, including educational settings. Applying this knowledge can help us set more realistic goals for children and know which children may need additional instruction in how to improve on a task. Recall that improvement or changes are from children's own intuition. Additionally, knowledge of children's learning patterns will provide us with insight into the nature of disorders like LI and dyslexia.

Participants

Before recruiting participants, we received IBR approval. The children included in this study (N=107) all met certain inclusionary standards. All children were 7-9 years old in the 2nd grade, had no history of neuropsychiatric disorders and received no special education for non-qualifying categories. This information was taken from a family questionnaire. The children were from Arizona, Massachusetts, and Nebraska public schools. All children had 20/32 near acuity vision, correctly responded to 8 out of 9 color plates demonstrating intact color vision, and passed a hearing screening at 20 dB at 1KHz, 2KHz, and 4KHz. All included children scored in the 31st percentile or greater on the Goldman Fristoe Test of Articulation- Second Edition (GFTA-2; Goldman & Fristoe, 2000) and if they scored less than the 31st percentile, phonemes needed to be produced correctly on two of three production attempts. All children achieved a standard score of 75 or greater on the Kaufman Assessment Battery for Children – 2nd Edition (K-ABC-2; Kaufman & Kaufman, 2004).

The Test of Word Reading Efficiency – Second Edition (TOWRE- 2;Torgesen, Wagner, & Rashotte, 2012) and Clinical Evaluation of Language Fundamentals – 4th Edition (CELF-4; Semel, Wiig, & Secord, 2003)were used to separate the children into diagnostic groups: typically developing monolingual English (N=48), typically-developing bilingual Spanish-English (N=48), dyslexic (N=14), LI (N=4), and comorbid LI and dyslexic (N=11). Children who achieved a standard score of 96 or greater for the TOWRE-2 and an 88 or greater on the CELF-4 were categorized as typically developing.

The typically developing group was then separated into typically developing monolingual and typically developing bilingual English and Spanish (N=30) based on both parental questionnaires and standardized testing. Children whose primary language was English and had primary caretakers who spoke English only, received instruction in English only from prekindergarten through 1st grade, and used English only were placed in the typically developing monolingual group. To be eligible for the bilingual group, children had to have a primary language of English, Spanish, or both and: 1) had at least one primary caretaker who spoke Spanish to the child at least some of the time 2), had instruction in English, Spanish, or both, in a way that complemented their home language (e.g., some instruction in English if the primary home language was Spanish, and vice versa) 3) were able to carry on a conversation in both English and Spanish. It would not be appropriate to determine language abilities for bilingual children using only an English standardized measure. Thus, bilingual children had multiple ways to gain inclusion using a variety of standardized tests. Bilingual children whose standard score was greater than 87 on the English CELF Core Language and had a score greater than 5 on the Formulated Sentences subtest of the Spanish CELF-4 (Wiig, Semel, & Secord, 2006). qualified for inclusion. Alternatively, bilingual children who scored between 78 and 88 on the English CELF-4 Core Language scale, and, greater than 69[1] on the Spanish CELF-4 Core Language scale, including a score of greater than 5 on the Formulated Sentences subtest of the Spanish CELF-4 also qualified for full inclusion to the bilingual typically developing group.

[1] Although these scores were low, they are data-based scores based on over 200 children analyzed by Barragan, Restrepo, Castilla-Earlys, Olivares, and Gray (2013). Using a standard score cut-off of 1 standard deviation below the mean, 85, greater than 60% of the 200 children from Phoenix would qualify to be categorized with a language impairment, which was unrealistic. Instead, 69, one standard deviation from the group mean, was used as the cut off score and produced 11% of children to be categorized as language impaired.

Children who scored a 96 or greater on the TOWRE-2 and an 82 or less on the CELF-4 were categorized as LI. Children who scored an 88 or less on the TOWRE and an 88 or greater on the CELF-4 were categorized as dyslexic. Children who scored an 88 or below on the TOWRE-2 and an 82 or below on the CELF-4 were categorized as comorbid. Other tests, including a nonword repetition task (Dollaghan & Campbell, 1998), expressive vocabulary test (Expressive Vocabulary Test – Edition; Williams, 2007), and a reading comprehension test (Woodcock Reading Mastery Test – Paragraph Comprehension, Woodcock, 2011) were used to describe children, but were not part of the inclusionary requirements.

Procedures

Once children were classified, they participated in a series of six sessions of word learning and working memory games across six separate sessions. The word learning games were played in a random order and only one word learning game was played in each session. A trained research assistant supervised the child while taking notes of anything that could affect the validity of the game. The research assistants were trained so that the games were standardized for all children. The children played the pirate-themed games on a touch screen computer and got to visit the virtual pirate shop after every session to use the virtual coins they earned during the games. Each word learning game consisted of five tasks. In this study, we are only focusing on one of the word learning tasks: phonological-visual linking.

Our pirate themed word learning game involved learning the name of four different monsters each session. For the phonological-visual linking task, children saw four monsters on the touchscreen and simultaneously heard the name of one of the monsters. Their job was to

touch the monster whose name was spoken. The children were never explicitly taught the names of the monsters, but they learned the names through feedback. When they got the name of the monster correct, they immediately earned a gold coin, and when they answered incorrectly they got a useless rock. In this task, there were four blocks-total. Block 1 included two exposures to each name and referent pair, and Blocks 2, 3, and 4 included 15 exposures each for a total of 47 exposures to each monster. After each block of the phonological visual linking task, the children were given other tasks in a random order. The other tasks included mispronunciation detection, naming, visual difference decision, and visual feature recall (please see Alt et al., 2017 for details on these tasks).

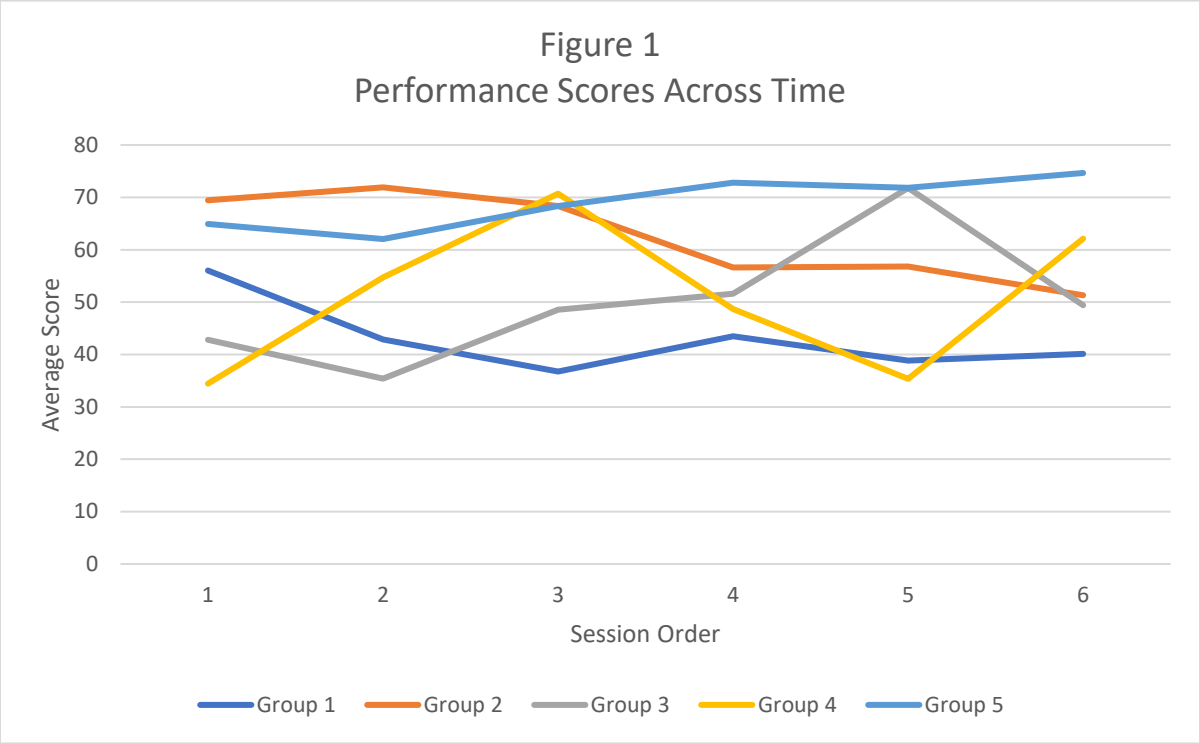
Results

Statistical Analyses

Our results only included children who completed all six data sessions. For each child, we determined the order in which each game was played, using our data collection records. Each child was assigned a score per session, with 'Session 1' being the first game he/she played. The scores for each session represented the average accuracy across all four blocks for the game played during that session.

Next, cluster analysis was performed, similar to the methods described in Yim et al. (2016). Specifically, nonhierarchical clustering was used to group students with similar learning profiles across the six sessions. Several iterations were run of each model in order to decrease the distance between the clusters. The best-fitting model, in terms of both distance between clusters and logical interpretation of the clusters was the 5-cluster model. After six iterations,

convergence was achieved. The minimum distance between the initial centroids is .651 for this model. Each cluster's performance, hereafter referred to as a group, is graphed in Figure 1.



The first group started off with a moderate level of accuracy then immediately decreased in accuracy, demonstrating a boredom effect. They continued with a low level of accuracy, and ended below their starting point, thus demonstrating no persistence. This group had the worst scores at the end. Group 2 started off well, maintained good scores until about the mid-point demonstrating some early persistence, then got bored and achieved consistently lower levels of accuracy. Group 3 started off with low accuracy, slowly improved until game five demonstrating persistence, then got bored. However, they ended with a score above their initial score. Group 4 started off with low accuracy, reached a peak in the middle demonstrating persistence, got bored, but then rebounded at the end. They ended with a higher score than

their first score. Group 5 started off with high levels of accuracy, maintained their high accuracy, and ended with an even higher score, demonstrating continual persistence. Group 5 had the highest percentage of children from four out of the five groups, including typically developing, bilingual typically developing, dyslexic, and comorbid dyslexic and language impairment (See Table 1 and 2).

Table 1: Percentage of Children from Each Diagnostic Category in Each Group

Column1	TD	BI	DYS	LI	LI + DYS
Group 1	14.58%	10.00%	21.43%	25.00%	18.18%
Group 2	4.17%	30.00%	21.43%	50.00%	0.00%
Group 3	22.92%	6.67%	21.43%	0.00%	9.09%
Group 4	4.17%	6.67%	0.00%	0.00%	18.18%
Group 5	54.17%	46.67%	35.71%	25.00%	54.55%

TD= typically developing monolingual English. BI= typically developing bilingual English and Spanish. DYS= dyslexic. LI= Language Impairment. LI+DYS= Comorbid language impairment and dyslexic

Table 2: Number of Children from Each Diagnostic Category in Each Group

Column1	TD	BI	DYS	LI	LI + DYS	TOTAL
Group 1	7	3	3	1	2	16
Group 2	2	9	3	2	0	16
Group 3	11	2	3	0	1	17
Group 4	2	2	0	0	2	6
Group 5	26	14	5	1	6	52
TOTAL	48	30	14	4	11	107

TD= typically developing monolingual English. BI= typically developing bilingual English and Spanish. DYS= dyslexic. LI = Language Impairment. LI+DYS= Comorbid language impairment and dyslexic

Table 3 describes the average age and maternal level of education of each group along with the average score on the inclusionary criteria tasks and descriptive tasks. We were interested to see if there were any statistically significant differences between the groups, so we ran separate ANOVAs for each of the continuous variables. The only variable for which there was a different was age ($F(4, 102) = 4.18$, $p=.003$, $\eta^{2partial}=.14$). We used Unequal N Honestly Significant Difference post-hoc testing to compare groups, and only found significant difference between the oldest (Group 2) and youngest (Group 4) groups ($p=.01$).

Table 3: Average Age, Mother's Level of Education, and Test Scores of Each Group[2]

Column1	AGE (Months)	MLE	ADHD	EVT	WRMT	TOWRE	CELF	KABC
Group 1	91.31	15.375	9.357	99.75	98.375	98.875	95.9375	108.6875
Group 2	96.937	13.8125	11.462	98.813	102.875	103.25	94.31	104.563
Group 3	92.647	14.765	7.667	105.588	105.765	103.647	103.412	106.706
Group 4	89.5	15.333	8.5	102.5	91.5	98.5	92.333	112.5
Group 5	94.365	14.51	9.591	102.519	102.596	101.981	99.077	111.385

MLE= Mother's reported level of education. ADHD: Parent questionnaire about child's attentive abilities. EVT= Expressive vocabulary test (Expressive Vocabulary Test – Edition; Williams, 2007). WRMT= a reading comprehension test (Woodcock Reading Mastery Test – Paragraph Comprehension, Woodcock, 2011). TOWRE= The Test of Word Reading Efficiency – Second Edition (TOWRE- 2;Torgesen, Wagner, & Rashotte, 2012). CELF= Clinical Evaluation of Language Fundamentals – 4th Edition (CELF-4; Semel, Wiig, & Secord, 2003). KABC= Kaufman Assessment Battery for Children – 2nd Edition (K-ABC-2; Kaufman & Kaufman, 2004).

For the categorical variables, we decided to focus on potential differences between the best performing (Group 5) and worst performing (Group 1) groups. Table 4 describes the gender, ethnicity, and race of the children in each group. Chi-squared analyses showed no significant difference between the two groups for ethnicity (X^2 (2, N = 68) = 3.37, p =.06) or, gender (X^2 (2, N = 68) = 0.29, p =.58), but there was a significant difference for race (X^2 (2, N = 68) = 8.50, p =.003). In order to calculate Chi-squared for ethnicity and race, we collapsed the two participants of 'unknown' ethnicity to the 'Not Hispanic' group, and given that 'white' was the most frequently reported race, collapsed all other races to yield a comparison of 'white' v. 'nonwhite'. The difference in race, as seen in Table 4, shows that the Group 1 (the low-performing group), had a higher percentage of children identified as white (93.75%) than children in the highest performing group (Group 5; 71.15%).

Table 4: Gender, Ethnicity, and Race of Children in Each Group

Column1	Gender	Ethnicity	Race
Group 1	8M 8F	10 Not Hispanic 6 Hispanic	15 white 1 black
Group 2	6M 10F	5 Not Hispanic 11 Hispanic	9 White 1 American Indian/Alaskan Native 2 more than one race 4 unknown
Group 3	8M 9F	12 Not Hispanic 3 Hispanic 2 Unknown	12 White 1 Black/African American 1 more than one race 3 unknown
Group 4	4M 2F	4 Not Hispanic 2 Hispanic	4 White 1 American Indian/Alaskan Native 1 Black/African American
Group 5	22M 30M	33 Not Hispanic 17 Hispanic 2 Unknown	37 White 2 American Indian/Alaskan Native 1 Black/African American 1 Asian 2 more than one race 9 unknown

Discussion

We predicted that there would be five different patterns in performance across time, including: 1. Improved performance across time (demonstrating learning from experience) 2) Improved performance followed by a decrease in performance (demonstrating learning from experience coupled with a boredom effect) 3) Consistent performance (demonstrating no learning from experience and no boredom) 4) Decreased performance (demonstrating a boredom or frustration effect) 5) No clear pattern (demonstrating the effect of other factors). We expect these patterns to be differentially distributed across the diagnosis groups.

Group 5 lines up with prediction 1 because there is improved performance across time and the last score was better than the first score. The increase in performance was gradual, not dramatic. Group 3 is similar to prediction 2 in that there is improved performance followed by a decrease in performance. Their improvement was more dramatic than Group 5, but they also had more room for growth. Group 1 and Group 2 are similar to prediction 4 because they both showed decreased performance across time, which we interpret as a boredom effect. Group 1 had an immediate drop off, with one mildly improved score between their 3rd and 4th game, but ended with the lowest score of all five groups. Group 2 had a very gradual decrease in performance. The main different between these groups is their starting points, and the point at which they evidence the boredom effect. Group 4 was similar to prediction 5 with no clear pattern, demonstrating both improvements (strategy use) and boredom effects. None of the groups fit prediction 3, consistent performance, because there were at least small fluctuations in performance in every group.

Group 5 performed the best and surprisingly contained a high percentage of children from every diagnostic category, with 48.59% of all children. We expected this group to consist almost entirely of typically developing children, expecting that the documented difficulties of the impaired groups would also manifest in poor experiential learning. Along the same lines, we expected the worst performing group to have fewer TD children and more impaired children. Group 1 was the worst performing group and contained children from all categories, as seen in Table 1. Although Group 1 and Group 5 were the worst and best performing groups, they had almost the exact same ADHD score. However, as predicted, there was a greater ratio of children in Group 1 compared to Group 5 from the impaired groups (1:2) than for the typical groups (1:4).Although a surprising 41% of impaired children were in the most advantageous group, Group 5, the majority of impaired children were not in the most advantageous group. The majority of TD children, 51%, were in the most advantageous group. These percentages differences are not as drastic as we predicted, but there are still slightly more TD children in the most advantageous group.

Prediction 4 lined up with Group 2 with a gradual decrease in performance. Group 2 started off with the highest score, then showed the boredom effect. Fourteen percent of typically developing children and 17% of impaired children were in this group. There were 16 children total in this group. Group 2 was the only group that consisted of a majority of Hispanic children. We were not particularly surprised with the distribution of children in this group because we did not have a strong prediction for the category of children who would have decreased performance, demonstrating a boredom or frustration effect.

Prediction 2 involved improvement plus boredom, which was similar to Group 3. Seventeen percent of TD children and 14% of impaired children were in Group 3. Group 3 had the lowest average ADHD questionnaire score, meaning we would have predicted that they would be the least likely to evidence boredom effects. We were not particularly surprised with the distribution of children in this group because we expected more impaired children in this group because the challenging task would be motivating for impaired children. Group 3 started at a low score, like we would expect impaired children to have, and then increased performance due to motivation. Their performance dropped when the task became less challenging and their motivation lessoned.

Prediction 5 involved random patterns, which was similar to Group 4. Five percent of TD children and 6% of impaired children were in this group. Group 4 had the lowest average scores on the non-word repetition task, reading task, and language comprehension task, but none of these differences were statistically significant. We were not particularly surprised with the distribution of children in this group because we did not have a strong prediction for the category of children who would show no clear pattern and possibly demonstrating effect of other factors.

There were no clear scores or categories that made it easy to tell which group a child might belong to. The only statistically significant difference between all of the groups was the average age, as seen in Table 3. Group 4 was the youngest group, while Group 2 was the oldest group with a difference of approximately 7 months. The youngest group showed no clear pattern, while the oldest group showed decreased performance, demonstrating a boredom or frustration effect. This is interesting because the older children showed the most prominent

boredom effect and the younger children showed the effect of other outside factors. There do not seem to be any real differences between the groups' scores on any of the tasks we administered. All of the groups consisted of a majority of white children. There was a lower number of white children in the higher performing group, which indicated the possibility of a cultural difference. For example, white children may not feel the need to continuously strive for a high score after they have already performed well once due to cultural differences at home or in society. If white children do not feel the need to impress or strive, then non-white children might feel the need to impress those around them with high performance scores and correct answers.

In conclusion, we found the different groups match up with four of the five predictions we made. Group 5 was in line with prediction 1 and showed improved performance across time, demonstrating learning from experience. Group 3 was in line with prediction 2 and showed improved performance followed by a decrease in performance demonstrating learning from experience coupled with a boredom effect. Prediction 4 lined up with Groups 1 and 2 with decreased performance demonstrating a boredom or frustration effect. Prediction 5 lined up with Group 4, showing no clear pattern and demonstrating the effect of other factors. Prediction 3, consistent performance demonstrating no learning from experience and no boredom was the only prediction that did not line up with any of the groups. Although impaired children are less likely to be in the most advantageous group, they are still capable of being part of this group. Having an impairment will make it harder for children to be in the best performing group, but it is not impossible. Similarly, TD children are more likely to be a part of the most advantageous group, but it is still possible for them to be a part of a lower performing

group. We are not aware of what the difference is between TD children who perform well and those who do not, along with impaired children who perform well and those who do not. The differences between the groups and the children that categorize the groups show us that there are more factors involved besides impairments.

One of the limitations of this study is that the time between each task varie d for each child. For example, one child could potentially complete the six session in one week and another child could potentially complete the six sessions in six months. This variability could change the child's memory of playing the game and therefore affect the child's strategy use. Another limitation is that there were a large number of children not included in this study because they did not complete all six sessions. One of the word-learning games was slightly different than the rest, focusing on action non-words instead of nouns. This difference could be result in a difference of performance due to the task instead of the child's learning ability. Future research should focus on learning across time for the same task, as well as looking to see if the amount of time that passes affects learning.

This study provides information on how children use untaught strategies to potentially improve performance across time. Our data for impaired children show that a large number of them are capable of learning across time without explicit strategy instruction. This is valuable because we need to give impaired children the same opportunities as typically developing children to succeed. In this study, it was clear that there was not just one category of children that was guaranteed to perform better across time using self-taught strategies. It is important to note that this may be different if we were discussing taught strategies. Further research can

aid in identifying children who benefit from self-taught strategies across time and children who are hurt by this.

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