Investigating Dandy-Walker Syndrome: Integrating Conversation Analysis and Reading Eye-Movements

Sunny Seeberger

Ryan Nelson

Nikki Curtis

University of Louisiana at Lafayette
Lafayette, Louisiana, USA

This paper presents an investigation into the reading eye movements of a 12-year-old child with Dandy-Walker syndrome and late onset stuttering. Conversation Analysis, video analysis, and Eye Movement Miscue Analysis (Paulson, 2000) were employed to evaluate visual sampling and oral production of this individual during a 27-second moment of difficulty during her reading of authentic texts. Initial clinical interpretations of this child's behavior during the period of difficulty suggested that she had opted-out of the reading process. However, fine-grain analysis of eye movement patterns during the selected segment of text demonstrates the structural and sequential ordering of her active engagement with the text throughout the period in question. Additionally, use of these multiple analyses revealed the meaningful confirmation strategies utilized by the child as she worked to make sense of print.

Key Words: eye movement miscue analysis, dandy-walker syndrome, conversation analysis, reading

Asia Pacific Journal of Speech, Language, and Hearing
Volume 12, Number 3, pp. 235–242

Introduction

Traditionally, studies examining the relationship between eye movement and reading have focused on an individual's reading of words in isolation or decontextualized passages (Paulson & Goodman, 1999). These reading tasks, void of authentic context, required readers to interact with texts in ways that are very different from authentic reading tasks (Edelsky, Altwerger, & Flores, 1991; Paulson & Henry, 2002). Because reading is more than simply verbally producing the letters on the printed page, readers must weave together information from their syntactic and semantic cuing systems as well as their prior experiences, with the aim of constructing comprehensibility from their interactions with print (Goodman, 1967; Smith, 2004). In order to determine how children create comprehensibility while reading, evaluation of the oral miscues produced by an individual transacting with authentic texts have been evaluated to reveal the online comprehending strategies employed by the reader as they engage in establishing comprehensibility (Goodman, 1967; Goodman & Goodman, 1994). To facilitate the study of eye movement patterns of individuals engaged in reading of whole, authentic texts, Paulson (2000) and Freeman (2001) integrated eye movement technology with Oral Miscue Analysis. Using this hybrid analytical methodology termed Eye Movement Miscue Analysis (EMMA), it is possible to observe the reading process as manifest through the eye movements of the reader.

Research investigating eye movement has identified several core physiologic facts relevant to the description of behaviors in which the eye engages during reading. To determine how a reader visually interacts with a text, a basic understanding of the underlying physiology is needed. Eye movements are described as either fixations of saccades. Rayner (1997) defines fixations as moments when the eye comes to rest. It is only during these fixations that the brain is capable of processing visual information. During moments of fixations only a small area is in focus. This is referred to as the foveal region and extends one to two degrees of the visual angle (Just & Carpenter, 1987). This means that three to six letter spaces are contained within the foveal region and thus in focus during any moment of fixation (Paulson & Freeman, 2003). Visual information outside of the foveal region is not in focus during moments of fixation. In contrast to fixations are saccades, which are the ballistic, jerky movements made by the eye between fixations. When the eyes are engaged in this saccadic movement, no information is processed visually. This movement can be in any direction, including backward eye movement to a portion of a previously read text referred to as a regressive fixation. Regressive fixations are understood to occur in the context of linguistic confusion or in the environment of particularly long, complicated, or unfamiliar words (Taylor & Taylor, 1983; Underwood & Batt, 1996).

Nelson, Damico, and Smith (2008) demonstrated the descriptive power of EMMA's application to investigate the reading behavior of children with communicative disorders. The use of this technology has potential to be combined with qualitative research traditions to more fully demonstrate and understand the complexity of reading in children with communicative disorders and/or a history of reading failure (Damico, Nelson, Damico, Abendroth, & Scott, 2008; Nelson, 2004; Nelson & Damico, 2006). The current study demonstrates this methodological potential for greater interpretive adequacy in understanding the reading behaviors in children with communicative disorders. Specifically, we sought to interpret oral reading eye movement data in a child with Dandy-Walker syndrome who stuttered during oral reading interactions. A variation on Sacks's (1992) Conversation Analysis was combined with video analysis and EMMA to more richly describe both linguistic and nonlinguistic behaviors of the participant. Integration of the methodologies was then employed to more closely analyze a 27-second segment of oral reading. This segment was chosen to shed light on what initially appeared to be a period

of inactivity coinciding with the participant's attempt to read a proper noun in a fictional story during a clinical assessment activity.

Before proceeding to the analysis of the segment in question, a description of the clinician's initial superficial interpretation of the reading interaction is relevant to reveal how the research questions emerged. Prior to the moment of difficulty, the child was reading orally from a research protocol including the children's book *Sideways Stories from Wayside School* by Louis Sachar (1978) electronically scanned and presented on a computer monitor as a bitmap image of the entire unaltered page. The child had not produced any oral miscues while reading the target page until she encountered the proper name *Magadonia*. When she came to this target word, she paused and looked at the computer monitor silently for 15 seconds until one of the clinicians prompted her to do the best that she could and move on. After the clinician's prompt, the child sat silently looking at the computer monitor for an additional 9 seconds before finally attempting to sound-out the target word. The result of the entire interaction was a clinically uncomfortable 27 seconds in which the child ultimately produced an inaccurate pronunciation of the target word. During this time, the clinicians were not sure if the child was still engaged in the reading process. In fact, initial clinical interpretations of the child's behavior throughout the time in question was that the child had opted out of the reading process entirely and was no longer engaged.

Fine-grained analysis, however, revealed complexity suggesting initial clinical interpretations were superficial and inaccurate. The results of the combination of methods employed in this study suggest the child actually was engaged in the process of reading during the time in question and was strategically interacting with the text in an effort to make sense of print. The inaccurate initial interpretation of the child's reading behaviors prompted several research questions:

- First, is there a structural and sequential organization to the participant's interaction with the text?
- Second, what strategies are employed by the participant during this interaction?
- And finally, what do the participant's eye movements reveal about this reading interaction?

Methodology

Participant

Data were collected from a 12-year-old female child in the seventh grade with a primary medical diagnosis of Dandy-Walker syndrome, which had been given at 10 years of age. Prior to obtaining this diagnosis, the child was originally diagnosed with Cerebral Palsy and Attention Deficit Hyperactivity Disorder (ADHD). The revised diagnosis, Dandy-Walker Malformation Variant, is characterized by a cyst in the fourth cerebral ventricle. Though common in children with this condition, this child did not manifest hydrocephaly. The ADHD diagnosis was maintained, for which the child was prescribed 20 mg per day of Focalin XR. According to parent report, this medication was administered intermittently.

In addition, the participant had a preexisting diagnosis of severe articulation and expressive language disorder. However, there was no documented evidence of an oral mechanism evaluation in the child's clinical file, with prior assessments of speech deficits attributed to cerebral palsy. There was no documentation of preexisting fluency deficits. She was referred to a university clinic in the Southwest United States to address parental concerns of fluency and reading comprehension difficulties. The parent reported an onset of severe stuttering behavior at 10;6. The child's dysfluencies were characterized by atypical patterns. No MRI had been conducted since the time of the onset of stuttering.

The child had attended public schools through the fifth grade. At the time of data collection, she had completed one year of home school education. The education-

al history provided by her mother included significant oral reading difficulties characterized by "deficits in decoding and comprehension." She had a reported fourth grade reading level. In fact, a school reading specialist and the child's neurologist predicted a maximal potential of sixth grade reading level abilities. The child's history of reading instruction focused exclusively on oral reading production including a major emphasis on decoding speed, accuracy of oral production, and appropriate verbal expression. According to parent report, the only reading strategy explicitly taught to the child was decoding by sounding out each target word.

Procedures

The hybrid design including Eye Movement Miscue Analysis (EMMA), Conversation Analysis, and video analysis was employed to analyze the participant's eye movements in conjunction with other behaviors during the 27-second segment under investigation. First, eye movements were collected using Applied Science Laboratory R6 Remote System (ASL R6) with video head tracking integration. Eye location and movement were captured in space by eliciting a corneal reflection and pupil response from the eye through the use of harmless infrared light directed at the eye. The eye tracker then recorded the position of one of the participant's eyes as x and y coordinates. The ASL R6 has a 60 Hz sampling rate and is accurate within 0.5 degrees of the visual angle. All data were stored on a computer hard drive.

Data were collected as the child was seated approximately 26 inches away from a 19-inch computer monitor. The eye and head tracking cameras were located just below the computer monitor. While asked to sit still, the child was unrestrained. Following a 9-point system calibration of the child's eye with the eye tracker, the scanned text was presented as a bitmap image slide show on the computer monitor. Descriptive statistics and fixation points were rendered using EYENAL and FIXPLOT software. Video and audio recordings were also obtained to allow for analysis of the child's face and any verbal productions made as she read the presented text. Additionally, video recordings were taken of the child's real-time eye movements from the ASL R6 scene monitor.

As part of an initial clinical assessment protocol, the participant was instructed to read an entire fictional passage aloud and then asked to retell the story upon completion. It was during this evaluation procedure, in particular during the read aloud section of the assessment, that the segment of interest included in this investigation arose.

Data Analysis

Following collection of the eye movement data, a hybrid of methodologies, including EMMA (Paulson, 2000), Conversation Analysis (Sacks, 1992), and video analysis, was utilized to evaluate the participant's eye movements in conjunction with other behaviors during the 27-second segment of oral reading under investigation. All data were synchronized using duration times. This allowed for moment-by-moment evaluation of the child's linguistic and nonlinguistic behaviors across different data sources. The EMMA technology allowed the clinicians to overlay information about the location and movement of her eye during verbal and nonverbal productions, as well as providing a fixation-by-fixation analysis of eye movements during this 27-second segment of oral reading.

Results

The child's eye movements during these 27-seconds are presented in Figure 1. The eye movement information is overlaid on the scanned text, with a line box drawn around the problematic target word within which any fixations would place at least a portion of the target word clearly in the foveal region, thus making at least part of the target

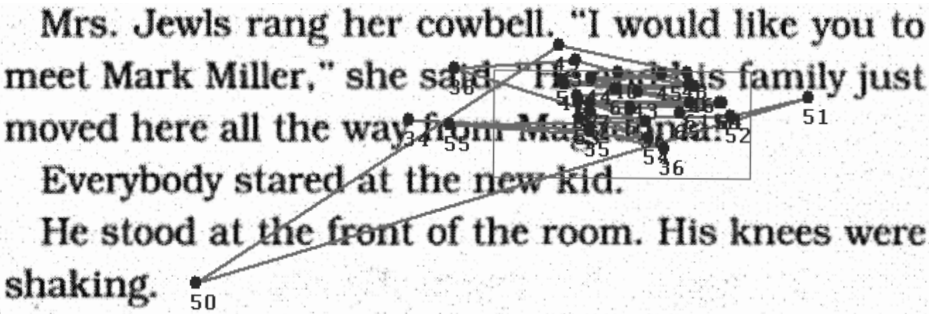

Figure 1. Eye movement during the 27 seconds under investigation. The line box around the target word indicates the foveal region for the target word.

word in focus. The captured fixations are indicated by numbered bullet points, with the lines connecting the fixations superimposed for the purpose of assisting in the identification of fixation ordering. Across the duration of the 27-second segment of interest, 31 eye fixations were recorded, ranging from 0.01 to 4.98 seconds in length. Twenty-four of these 31 fixations occurred within the foveal region of the target word *Magadonia*. In addition, 13 of the 31 fixations can be classified as regressive fixations, including seven within-word and six across-word regressive fixations. Of these, four across-words regressive fixations were found to be within the foveal region of the target production. The other two across-words fixations were outside the foveal region.

Several other significant behaviors were noted during this 27-second segment through the use of video analysis and Conversation Analysis. The child was observed to lean forward slightly toward the screen as she made the first three fixations on the target word. Following the first two regressive fixations, she was observed to silently mouth "ma" in an attempt at the target. A second silently mouthed attempt was made just before an instruction by one of the clinicians to do the best she could and move on with the oral reading task. The child glanced briefly away from the monitor as the clinician spoke resulting in a temporary loss of eye tracking information. Following the clinician's prompt, the child returned her gaze to the monitor and her eye movements again were tracked. A third silently mouthed attempt was made, coinciding with fixations in the foveal region of the target word. Of particular interest, the clinicians noted that a regressive fixation occurred on the word *from*, a word she had not fixated on previously and one which she had accurately produced just prior to the 27-second segment under investigation. This regressive fixation was followed by multiple fixations within the foveal region of the target word. Then the participant made an inaccurate verbal attempt of the target, realized as "mag+on+dan+uh." Afterward, she leaned back slightly in her chair and continued with the rest of the oral reading task.

Interpretations

Evaluation of the eye movement fixations suggest the participant employed a structured and systematic approach to the reading task. The number of eye movements and the silently mouthed attempts at the target word indicate that the child was actively engaged in the sense-making process of reading during the 27-second segment investigated in this study. Given that regressive eye movements are made at the point of linguistic confusion or with particularly difficult words (Paulson & Henry, 2002; Taylor & Taylor, 1983; Underwood & Batt, 1996), the 13 regressive movements verify

that this child was engaged in the process of constructing meaning from print. This conclusion is also supported by the fact that 11 of the 13 regressive movements were within-word, suggesting that she was trying to address the difficult word by carefully examining it, a strategy consistent with her previous decoding-intensive reading instruction. This target word was a long and fictional proper noun likely never before encountered by this child, and one that might be expected to result in linguistic confusion. Her ultimately inaccurate and segmented production of the word confirms that indeed this word was problematic in spite of the fact that she had visually inspected the word for some time. This finding is consistent with previous research suggesting that words miscued by both impaired and typically developing readers tend to be fixated on more often and for longer periods of time than other words (Nelson et al., 2008; Paulson, 2002).

An example of the structural and sequential organization of the child's eye movement patterns are illustrated in Figure 2. This segment includes the time frame just after the clinician's prompt through the child's verbal attempt at the target. Again, the fixations are indicated by numbered bullet points with the lines superimposed to assist in revealing the sequential occurrence. In this sample, the child exhibits two regressive fixations from 51 to 53. She then moves forward to fixation 54 before moving back to fixation 55. Next, she moves back to the target word at fixation 56. This is followed by another regression to 57 before moving forward to fixation 58. Throughout this sample of eight eye movement fixations, the child demonstrates engagement with the text, although her lack of a successful verbal production led the clinicians to initially conclude the contrary. Not only was the child carefully attending to the text at hand, she was actively attempting to work out the confusion, as evidenced by the multiple regressive movements.

These fixations following the clinician's comment are particularly interesting. The child glanced briefly away from the monitor in the direction of the clinician and then returned her gaze to the monitor, fixated on the target word, and then made a third silently mouthed attempt at sounding out the word. Following this attempt, she produced a regressive fixation on the word *from* (fixation 55). This word just precedes the target and although she had previously produced the word verbally, she had not fixated on it at the time of oral production. Current literature supports the notion that familiar words, particularly those that are not content words, are frequently unfixated by typical and struggling readers during the reading process (Duckett, 2001; Freeman, 2001; Paulson, 2000). In this case, the regressive eye movement fixation to the word *from*, secondary to her oral production, is indicative of strategic attempts to identify possible interpretations of the meaning of the unknown word *Magadonia*. The preposition *from* in this instance contextually constrains the syntactic and semantic category possibilities of the following word. In effect, this preceding word and the participant's subsequent visual inspection of the word just be-

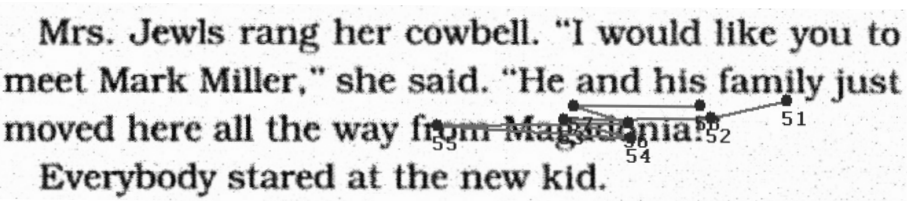

Figure 2. An example of the structural and sequential organization of the child's eye movement patterns.

fore her verbal attempt at the target word indicate that she was accessing her syntactic and semantic cueing systems in order to psycholinguistically guess meaningful possibilities of the target word (Goodman, 1967).

The number and duration of fixations on the target word and the number of the within-word regressive fixations suggest that the child is attempting to employ her primary strategy of sounding out the word. This is confirmed through the video analysis evidence of her silently mouthing segments of the word. However, given that this is a fictional proper noun, the focus on word accuracy is not an effective strategy. In such instances, letter-sound relationships are insufficient for determining word meaning. Her conception of reading as an "accuracy in the decoding process" manifested in her need for external approval before she would attempt a word that had little consequence for understanding the overall meaning of the story. After 19 fixations from the initial moment of difficulty, 13 of which were on the target word, the child produced a regressive fixation to the word just before the target word, perhaps to confirm the nature of the target (it was a proper noun) and then produced additional within-word fixations, before finally verbally attempting the word 27-seconds later, after which she leaned back in her chair and continued with the reading.

This child's primary strategy for working with print was letter-to-sound decoding as this was the only strategy that had been given to her throughout her formal reading education. The neglected cueing systems (i.e., syntactic, semantic, pragmatic) available for making sense of print did manifest themselves in spite of pedagogical failure to develop them, once again, demonstrating the child's active engagement in the process of meaning-making. Fine-grain eye movement analysis of this segment captured what was most likely a meaningful confirmation strategy that tapped into the child's syntactic cuing system as she actively worked to make sense of print.

Implications

The findings of this investigation describe the active engagement in meaning-making that this child superficially did not appear to manifest in the clinician's initial assessment. Implementation of the hybrid design incorporating EMMA, Conversation Analysis, and video analysis allowed for fine-grain analysis of the child's interaction with the text. Although the child appeared to be delaying the reading process in the face of an unfamiliar and difficult to decode word, the analysis undertaken in this investigation permits the identification of several essential indications that the process of meaning-making was in operation. Most importantly, these findings display the value that rich description and thick interpretation can provide in understanding a seemingly straightforward, frequently occurring literacy phenomenon. Furthermore, these findings reveal that clinicians may need to be more circumspect when determining the engagement level of those they serve. Such a view too often is lacking when clinicians and researchers view reading solely as a decoding process and focus only on splinter skills such as reading fluency, decoding accuracy, and words read per minute. This misplaced attention may cause clinicians to underestimate their clients' strengths and possibly their capacity for more successful interactions with print. In spite of the best efforts of this child's educators, these findings suggest that, for her, reading in fact, is a synergistic process of making sense of print.

Address Correspondence to: Ryan Nelson, University of Louisiana at Lafayette, Lafayette, LA; Tel: 915-630-3023; E-mail: rleen4@gmail.com

References

Damico, J., Nelson, R., Damico, H., Abendroth, K., & Scott, J. (2008). Interactional changes

across unsuccessful and successful reading performance. *Clinical Linguistics and Phonetics, 22,* 283–291.

Duckett, P. (2001). First grade beginning readers' use of pictures and print as they read: A miscue analysis and eye movement study. *Dissertation Abstracts International, 62*(06), 2031A. (UMI No. 3016465)

Edelsky, C., Altwerger, B., & Flores, B. (1991). *Whole language: What's the difference?* Portsmouth, NH: Heinemann.

Freeman, A. (2001). The eyes have it: Oral miscue and eye movement analysis of the reading of fourth grade Spanish/English bilinguals. *Dissertation Abstracts International, 62*(08), 2715A. (UMI No. 3023532)

Goodman, K. (1967). Reading: A psycholinguistic guessing game. *Journal of the Reading Specialist*, *64*, 126–135.

Goodman, Y. M., & Goodman, K. S. (1994). To err is human: Learning about language processes by analyzing miscues. In R. B. Ruddell, M. R. Ruddell, & H. Singer (Eds.), *Theoretical models and processes of reading* (pp. 101–123). Newark, DE: International Reading Association.

Goodman, Y. M., Watson, D. J., & Burke, C. L. (1987). *Reading miscue analysis: Alternative procedures.* New York: Robert C. Owens Publishers.

Just, M., & Carpenter, P. (1987). *The psychology of reading and language comprehension.* Newton, MA: Allyn and Bacon.

Nelson, R. (2004). Investigation of the process of improved literacy construction in individuals with poor reading abilities and an identification of language impairment. *Dissertation Abstracts International, 65*(11), 5674B. (UMI No. 3153731)

Nelson, R., & Damico, J. (2006). Qualitative research in literacy acquisition: A framework for investigating reading in children with language impairment. *Clinical Linguistics and Phonetics, 20*, 631–639.

Nelson, R., Damico, J., & Smith, S., (2008). Applying eye movement miscue analysis to the reading patterns of children with language impairment. *Clinical Linguistics and Phonetics, 22,* 293–303.

Paulson, E. (2000). Adult readers' eye movements during the production of oral miscues. *Dissertation Abstracts International, 61*(05), 1787A. (UMI No. 9972086)

Paulson, E. (2002). Reading psychology: Are oral reading word omissions and substitutions caused by careless eye movements? *Reading Psychology, 23,* 45–66.

Paulson, E., & Freeman, A. (2003). *Insight from the eyes: The science of effective reading instruction.* Portsmouth, NH: Heinemann.

Paulson, E., & Goodman, K. (1999, January). *Influential studies in eye-movement research. reading online,* Retrieved October 20, 2006, fromhttp://www.readingonline.org/research/eyemove.html

Paulson, E., & Henry, J. (2002). Does the degree of reading power assessment reflect the reading process? An eye movement examination. *Journal of Adolescent and Adult Literacy, 46,* 234–244.

Rayner, K. (1997). Understanding eye movements in reading. *Scientific Studies of Reading, 1*, 317–339.

Sachar, L. (1978). *Sideways stories from Wayside School*. New York: Harper Collins Publishers.

Sacks, H. (1992). *Lectures on conversation, Vols. I & II*. Oxford: Blackwell.

Smith, F. (2004). *Understanding reading* (6th ed.). Mahwah, NJ: Lawrence Erlbaum Associates.

Taylor, I., & Taylor, M. (1983). *The psychology of reading.* New York: Academic Press.

Underwood, G., & Batt, V. (1996). *Reading and understanding*. Oxford: Blackwell Publishers.