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Applying eye movement miscue analysis to the reading patterns of children with language impairment

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Abstract
This paper presents a research report on an investigation into the reading eye movements of a bilingual 10-year, 10-month old girl with language impairment secondary to Downs Syndrome. Eye movement miscue analysis (Paulson, 2000) was employed to evaluate the visual sampling and oral productions of this child as she read from complete texts presented in Spanish and English. Results are presented in relationship to misconceptions manifest in the clinical practice of intervention providers. Based upon the research and this data, readers do not fixate on every word and the miscues they produce are not the result of failing to fixate on the text.

Keywords: *Eye gaze, literacy, miscue analysis, language disorder reading*

Introduction

There are a number of misconceptions in the language arts literature that may impact clinical practices directed toward children with reading difficulties. In an attempt to correct several of these misconceptions, this paper provides data from an investigation into the eye movement patterns of a bilingual child with language impairment and links the data with a discussion on why these misconceptions must be modified. To accomplish this objective, the paper is organized in the following way. First the topic of eye movement miscue analysis (EMMA) (Paulson, 2000; Duckett, 2001; Freeman, 2001) is briefly introduced. Next, the methodology of the pilot study is reported. Descriptive results from the oral reading eye movement patterns of a bilingual child with language impairment secondary to Downs Syndrome are provided based upon her interaction with complete, authentic text. Clinical misconceptions are then presented and addressed in light of the pilot findings and current research. Finally caveats are provided for the reader to keep in mind when considering the implications of this study.

Development of eye movement miscue analysis

In 2000, Paulson reported the first use of a hybrid analytical methodology he termed ''eye movement miscue analysis'' (EMMA) that more effectively addresses issues in literacy

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research. Eye movement miscue analysis combines two previous research methodologies in literacy. The first is oral miscue analysis as designed and promoted by Kenneth Goodman (Goodman, 1967). This approach to literacy investigation is grounded in focusing on the oral reading miscue analysis wherein oral productions made by individuals during reading are believed to reflect the cognitive interaction a reader engages in with the text while reading aloud (Goodman & Goodman, 1994; Paulson & Freeman 2003). According to Goodman (1996), reading is described as the process of constructing meaning from print. From this perspective reading is a transactional interaction between the individual reader and texts for the purpose of making meaning. That is, reading is more than simply verbally producing the letters on the printed page; it is the child's establishment of comprehensibility from an interaction with written symbols. In order to investigate how children make sense of print, evaluation of the oral miscues produced by individual's reading from authentic texts have been evaluated to reveal the on-line comprehending strategies employed by the reader as they engage in establishing comprehensibility (Goodman 1967; Goodman & Goodman, 1994).

Specific procedures have been established for oral reading miscue analysis (Goodman, Watson, & Burke, 1987). When conducting oral reading miscue analysis, the investigator routinely audio records the reader's verbal productions of the text. The productions are then transcribed and analyzed to identify discrepancies between the text and the productions made by the reader. These discrepancies are viewed not as errors but as mental miscues reflective of how the reader uses his/her background information on language and knowledge of the world (i.e. cueing systems) to construct meaning during verbal production. Careful evaluation of the quality of miscues produced in conjunction with the readers overall ability to retell the portion of text can disclose the process of meaning construction.

The second research methodology employed involves eye movement analysis. Eye movement patterns and visual perception in literacy have been studied for over 100 years (Huey, 1908; Paulson & Goodman, 1999; Paulson & Freeman, 2003). From the history of eye movement studies two basic physiological facts have emerged that are relevant to the discussion in this paper. First, eye movement is discussed in terms of saccadic movements between moments of fixation. The saccades are ballistic jerky movements made by the eye during which no information is processed visually (Paulson & Freeman, 2003). Fixations are those moments when the eye comes to rest and it is only at these times when the brain is capable of processing visual information. The second physiological fact that must briefly be mentioned concerns how much information is in focus during the millisecond long moments of fixation. It is well documented that during the fixation, the foveal region of the eye restricts the amount of information that is in focus; therefore all information outside of the region is perceived rather than observed physiologically (Just & Carpenter, 1987). Typically, for the purposes of reading, the foveal region consists of approximately three letter spaces on either side of the fixation point (Just & Carpenter, 1987; Rayner & Sereno, 1994). These two facts are crucial for interpreting the eye movement patterns of individuals engaged in reading.

Traditionally, eye movement studies have focused primarily on the individual's reading of words in isolation or decontextualized passages. Recently, Paulson (2000), Freeman (2001), & Duckett (2001) integrated eye movement technologies with oral miscue analysis in order to gain insight into the eye movement patterns of adults and bilingual children engaged in reading whole texts. In the same way that audio recording captures the oral miscues produced by a reader, eye movement recordings serve as a data collection tool for

EMMA by functioning as a ''tape recorder for the eyes'' (Paulson & Freeman, 2003). This recording provides insight into where and how an individual visually samples from texts. What makes EMMA unique is that by looking at the fixations produced as the reader reads and simultaneously overlaying that with their verbal production, the investigator obtains interpretive adequacy with both the nature of the eye movements and the stimulus source influencing verbal productions. This hybrid form of analysis has been demonstrated to provide additional insight into the process of reading with adults (Paulson, 2002; 2005; Paulson & Henry, 2002; Paulson, Flurkey, Goodman, & Goodman, 2003), as well as with typically developing and bilingual children (Duckett, 2001; Freeman 2001; Duckett, 2003; Paulson & Freeman, 2003). The investigation, from which the data presented below is derived, was initiated in an attempt to extend this method of inquiry to the process of reading acquisition in impaired populations. While this forum does not allow a complete discussion of the research and implications, there are several results that can be emphasized in this short article. It is to these results that the discussion now turns.

Methodology

Participant

Data were collected from a 10-year, 10-month old female bilingual child with language impairment secondary to Downs Syndrome. At the time of the study, the child (here after referred to as Maria) was a Mexican citizen from an upper class family in a North Mexican city. She had just completed fourth grade at a private school in the community where she lived and was recruited based upon her parents' familiarity with the university clinic where the first and third authors work. Consistent with her syndrome, parental report places Maria's functioning considerably lower than that of typically developing multilingual children. Maria was previously diagnosed with moderate receptive and expressive language impairment in conjunction with impaired cognitive functioning. Formal cognitive testing had not been conducted largely due to lack of special education services in her region of Mexico. Maria presented with functional hearing determined to be within normal limits bilaterally. According to parental report, Maria has 20/20 corrected vision. However, Maria was capable of reading and working on academic work without her glasses. While Maria had completed the fourth grade, her independent reading abilities were determined to be at a first grade developing reader level in both languages. She is a stronger and more experienced reader in Spanish and prefers to read in Spanish verses English. This is most likely attributed to that fact Spanish is the primary language spoken in her home; however, her education has included English as a second language since she was four years old. Both Maria and her mother signed Institutional Review Board approved consent forms prior to participating in the study.

Procedures

Data were collected from Maria's reading of a children's storybook both in Spanish and English. *Huggly Gets Dressed* (Arnold, 1999) was selected as the English text and *Mi Abuela Y Yo* (*Just Grandma and Me*; Mayer, 1983) was presented in Spanish. These books were determined by the researchers and Maria's mother to be the type of books Maria would most naturally engage in reading. Maria was not familiar with the books; however, she was familiar with each book series. In accordance with EMMA procedures, each book was

scanned and stored electronically as a bitmap image. Maria was seated in a chair positioned approximately 25 inches from a 19-inch monitor. The eye and head tracking cameras were located just below the monitor. She was instructed to sit as still as possible; however, the head and eye tracking technology allowed for some movement on Maria's part. Following a nine-point system calibration of Maria's eye with the eye tracker, the scanned bitmap images were presented via the 19-inch monitor as a slide show. Maria was asked to read the book aloud with instruction that upon completion she retell the story in her own words. The Spanish text was presented first. Following Maria's retelling of that text, the second story was presented in English followed by the second retelling. The entire procedure including calibration and reading of the story in each language with the corresponding retellings took approximately 40 minutes.

Data collection and analysis

Data were collected and analyzed through two means. First, eye data were collected using the Applied Science Laboratory R6 Remote System (ASL R6) with video head tracking integration. This system captures eye and head movement in an unobtrusive manner as individuals read from a single viewing plane. Eye location and movement are captured in space through the use of harmless infrared light directed at the eyes to elicit a corneal reflection and pupil response from the eye being tracked. The eye tracker records these locations as eye positions on x and y coordinates. The ASL R6 tracks eye movement at a 60Hz sampling rate with a 0.5 degree of visual angle accuracy. The researchers did monitor accuracy during data collection by observing the real-time eye image and position as displayed on an eye and scene monitors located out of the child's view. Data are stored on a computer hard drive. The software packages EYENAL and FIXPLOT were used to derive descriptive statistics from the data and convert the x and y coordinates into fixations points. These fixations were then appended on the corresponding bitmap image file. In this way the specific fixations produced by the child were displayed in direct relationship to the corresponding page in the electronically presented book.

The second form of data collection consisted of digital video recording of the scene monitor that included the real-time display of the child's eye during the act of reading. Additionally, the video taping included audio recording of the child's verbal productions. This information was used to complete the oral miscue analysis (Goodman & Goodman, 1994) and subsequent EMMA (Paulson 2000; Duckett, 2001).

Results

Results of Maria's oral reading miscue analysis from both texts are represented below in Table I. The length of the text in terms of words was relatively similar as were the

Table I. Maria's Spanish and English oral reading miscue analysis data.

	Spanish	English
Words in Text	239	245
Percent of Text Miscued	12.6	13.5
Percent of Low Quality Miscues	08.4	07.3
Percent Low Quality Miscues – Substitutions	80.0	77.8
Percent of High Quality Miscues	04.2	06.1
Percent High Quality Miscues – Substitutions	50.0	46.7

percentage of miscues Maria produced in each language. From the Spanish text Maria miscued on 12.6% of the text. A total of 8.4% of those miscues were determined to be low quality. That is, if left uncorrected, approximately 8% of Maria's miscue production would negatively alter the meaning of the text either through syntactic or semantic substitutions, insertion or omissions. The 4.2% of text that contained high quality miscues did not alter the content of text in a way that detracted from the overall meaning of the story. As will be explained below, it is relevant to note that 80.0% and 77.8% of the low quality miscues produced in Spanish and English respectively were substitution miscues. That is, Maria produced another word for the word on the printed page that was so different in content and/or form that it negatively impacted the meaning of the text. This issue will be revisited in light of the eye movement findings in the ''Implications'' section of the paper.

Following the reading of the Spanish text Maria was asked to retell the story in her own words. Without the aid of the text, she was able to recall the central theme and the main characters of the story. When provided with the text as an aid, Maria simply added to her retelling description of the illustrations on whatever page she was currently viewing. With the English text her retelling was somewhat different. Without the aid of the text, Maria did not retell any aspect of the story. When provided the opportunity to convey an aided retelling, she was able to recall the central theme and one of the main characters; however, her aided retelling contained similar simple descriptions of the illustrations on specific pages. It was obvious, in the case of these two stories, Maria was more confident in her retelling of the story read in Spanish.

The results of the eye movement analysis are represented in Table II below. From the 239 words in the Spanish text, Maria fixated on 77.3% (approximately 185) of the words. The percentage in English was similar with 81.1% of the text receiving fixations (approximately 200 of the 245 words). From the eye movement data, regressive eye fixations were counted as well. Regressive fixations are counted when the reader produces a fixation that deviates from the left-to-right, top-to-bottom progression (in English and Spanish). In short, a regressive movement is a backward eye movement (Taylor & Taylor, 1983; Underwood & Batt, 1996; Paulson & Freeman, 2003). From the total fixations made by Maria, 15.2% and 11.2% were determined to be regressive.

Simply calculating the eye movement data does not provide considerable insight into how a reader makes sense of print. Without some means of measuring the comprehension level in relationship to the specific fixation point interpretive adequacy cannot be established. Therefore, Figure 1 contains an example of integration between miscue analysis and eye movement analysis needed for EMMA.

In Figure 1, the fixation points are represented as dots with numbers directly below each dot to indicate the sequence in which each fixation occurred. The lines connecting each fixation were added to assist in following the eye movement progression. For example, the text reads ''Huggly peeked out from under the bed''. While orally reading this segment of text Maria produced one low quality miscue by substituting a nonsense word ''pickid'' for

Table II. Maria's Spanish and English eye movement data.

	Spanish	English
Words in Text	239	245
Percent of Words Fixated	77.3	81.1
Percent of Regressive Fixations	15.2	11.2

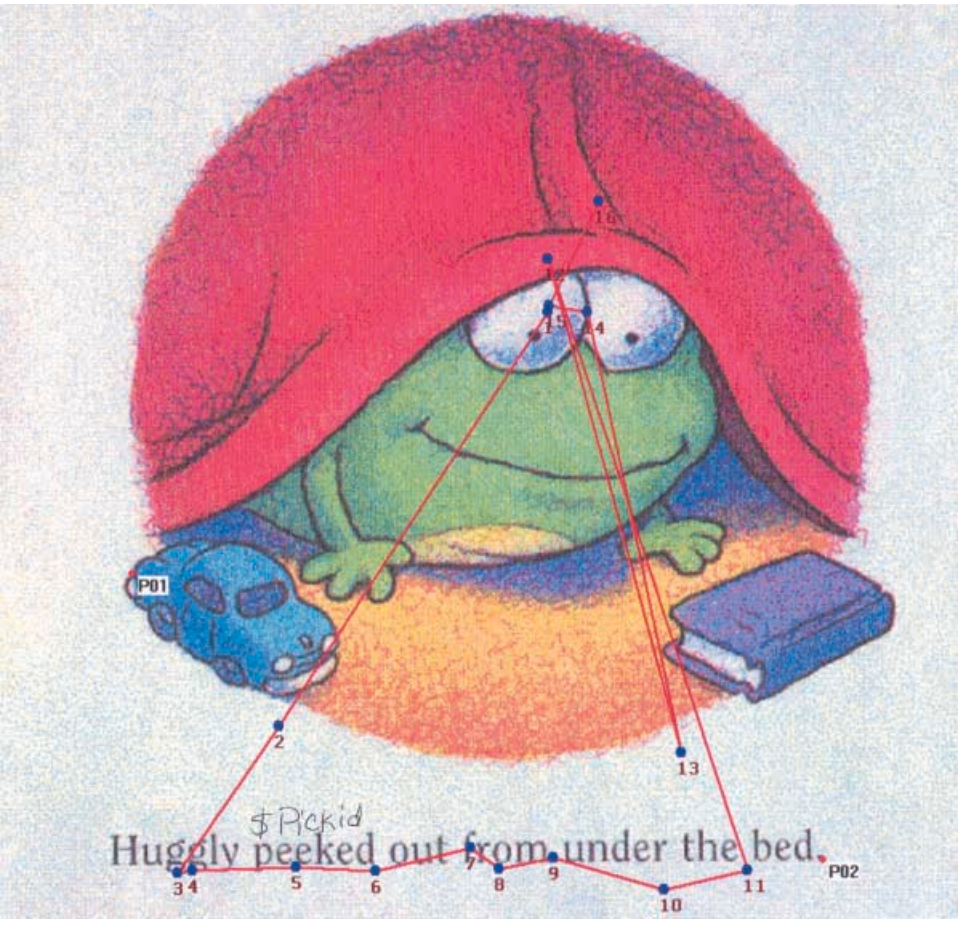

Figure 1. Integration between miscue analysis and eye movement analysis.

''peeked''. Additional analysis and implications of this example are discussed in the next section.

Implications through eye movement miscue analysis

Within this short research report, the implications of the previously reported data are best addressed through discussion of two misconceptions that appear to exist in the clinical intervention literature directed at individuals with impairment and difficulty reading. While there are several implications only two of the most salient are presented here due to limitation in space.

Misconception 1: developing readers should fixate on every letter or at least on every word while reading.

According to a number of texts and articles focusing on the literacy intervention with struggling exceptional readers (e.g. Gough, 1972; Adams, 1990; Adams & Bruck, 1995),

there is a belief that readers should carefully examine every letter or at least every word prior to making a verbal production. Consequently, advocates of this misconception teach reading by breaking words down into their isolated components and teaching decoding strategies from a smallest to progressively largest sequence (e.g. Swank & Catts, 1994; Lyon, 1999; National Reading Panel, 2000). Some clinical instructors even develop ''word windows'' where strips of paper are positioned over the text with a small window cut from the strip so that only one word at a time can be observed. With all of the ''extra'' visual stimuli covered, the developing reader is then forced to visually attend to the isolated word.

Reality 1

The reality of this misconception is manifest through honest evaluation of the eye movement literature in typically developing individuals. Readers, even developing readers, do not fixate every letter, let alone every word while reading. The fact is that great variability exists in the percentage of words that readers fixate. What is clearly manifest is that a substantial portion of the text is often skipped. Rayner (1997) has suggested anywhere between 20% and 30% of the text was skipped by participants in his study while Just and Carpenter (1987) found that their participants omitted approximately 30% of text. In reality the literature suggests that anywhere from 60% to 80% of text is fixated by readers with the remaining percentage being skipped by the eyes altogether (Hogaboam, 1983; Paulson & Goodman 1999; Paulson 2002)! Indeed, Duckett (2001) found that even with beginning readers only approximately 80% of the text was fixated. The degree of fixation is consistent with Smith's (2004) position that the more information readers have behind the eyes and between the ears, the less they need to rely on what is in front of the eyes. That is, as Rayner and Well (1996) have suggested, when words are contextually constrained, they are more likely to be skipped. Familiarity of topic and proficiency with meaning construction clearly plays a major role in dictating how many words will be fixated and which words need to be fixated.

It is likely that the primary reasons readers develop this sampling approach is due to a combination of the limitations of human physiology and the power of language and meaning making to overcome these limitations. That is, given the physiological limitations of the eye and brain as manifest through the foveal region, the brain cannot directly process sensory data beyond the foveal boundaries. To help construct this greater information set, however, the meaning maker employs language to construct the missing data (Bruner, 1957; Smith, 2004), consequently the reader perceives that the information outside of the region exists and through meaning-based strategic sampling the reader confirms the perceptual predictions constructed by the brain. In short, meaning strategically drives eye movement sampling and not a need to fixate every letter or word of the text.

The findings from Maria's readings in both Spanish and English concur with the research described in typically developing readers. She fixated only 77.3% of the words in Spanish and 81.1% of the words in English. This is clearly illustrated in the eye movement represented in figure 1. She does not directly fixate ''out'' or ''under'' and only fixates in the general area between ''the'' and ''bed''. However, she accurately produces all of those words and indicates her comprehension of the meaning by fixating directly where the action is taking place (i.e. peeking out from under the bed) with fixations 12, 14, 15 and 16.

If readers do not fixate every word or every letter when reading, clinical practices that attempt to force readers into these patterns could potentially complicate the process of reading. Practices of covering aspects of texts may further complicate matters when

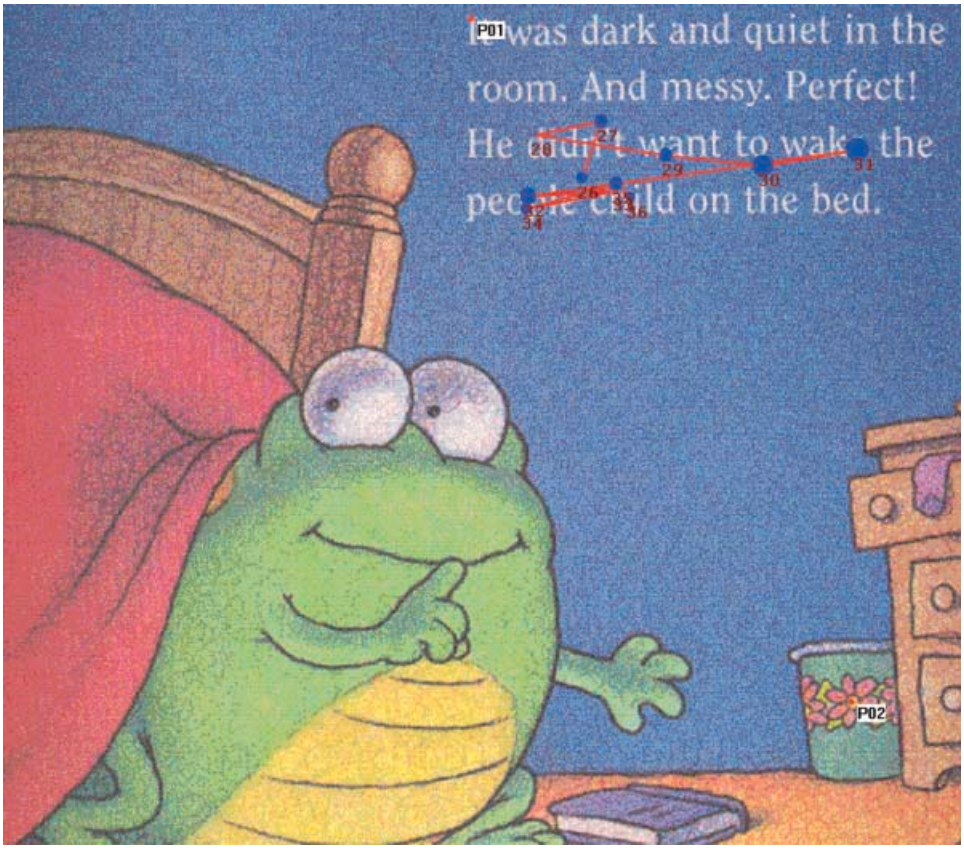

Figure 2. Examples of Maria's regressive eye movements.

regressive eye movements are considered. Figure 2 contains illustrative examples of Maria's regressive eye movements from her reading in English.

This example contains both intra-word (fixations 27 and 28) and inter-word (fixations 32–36) regressive fixations. The first fixation produced in this example is numbered 26. Fixation 27 is produced on the apostrophe in ''didn't'' with a regressive fixation following (28) at the beginning of the same word. Regressive eye movement across words is manifest when Maria moves from fixation 33 on ''child'' to fixation 34 in an almost identical location as fixation 32 in the word ''people''. She then moves back to ''child'' for fixations 35 and 36. It is important to note that Maria did not produce any oral miscues while reading this page.

According to Underwood and Batt, ''Regressive fixations usually are launched to areas of the text that have caused linguistic confusion, or contain particularly complicated words'' (1996: 146). That is, when the fixations produced by the reader do not provide the visual input expected for constructing meaning, the reader then has their eyes return to a portion of the text to sample again. Rayner and Pollatsek (1989) suggest that typically, 10% to 20% of eye movement fixations are made up of regressive movements. This is consistent with more recent findings as well (Paulson, 2000; Duckett, 2001; Freeman, 2001). Maria's percentages of regressive eye fixations fall within this expected window as well with 15.2% and 11.2% regressive fixations in Spanish and English respectively.

In the instances demonstrated in Figure 2, EMMA revealed that Maria's eye movement was ahead of her voice as she read. This is also consistent with the phenomenon described by Duckett (2003) as eye-voice span. While her vocal productions were being produced, Maria's eyes had actively moved on to new points in the text. The regressive eye movements described in Figure 2 most likely assisted Maria in confirming potentially problematic portions of the text. This regressive movement was timely enough to ultimately result in an accurate production of the printed text.

From the clinical intervention perspective, if clinical service providers insist on strict linearly driven oral productions of printed words while reading, it stands to reason that the naturally occurring regressive eye movements produced by readers will be negatively impacted. It becomes obvious in light of these findings that covering aspects of the text can prevent effective regressive eye movements and confound the reading process. Additionally, the eye-voice span displayed by typically developing children reported in the literature and the behaviours noted by Maria (a language impaired child) raises serious concern about teaching and intervention strategies that require the learner to match verbal production with decontextualized print. In effect, such misdirected strategies will reduce the availability and effectiveness of the reader's knowledge of language to create expectations that enhance the construction of meaning. Such misdirected strategies will likely make the process of reading more difficult rather than less difficult.

Misconception 2: most ''errors'' or miscues that developing readers produce tends to reflect words that were not fixated.

Again, this belief is often stated in the literacy pedagogical literature when discussing exceptional learners (e.g. Lyon, 1999; Moats, 1999). Consequently, according to such beliefs, when readers orally produce words that are not consistent with what is on the printed page, they should be instructed to look closer at the word because they have obviously been careless in there visual inspection of the target word.

Reality 2

The three primary researchers who have used EMMA to investigate reading patterns in readers ranging from first grade to adults have consistently demonstrated that this misconception is not supported by the physiological data (Paulson, 2000; Duckett, 2001; Freeman, 2001). Paulson (2000) found that over 90% of the words containing substitution miscues were focused on prior to the production of the oral miscue in adults. Duckett's (2001) findings were consistent with this number as well in his investigation of first grade developing readers. All of these researchers concluded that in addition to simply fixating on the words, the duration of the fixations for substitution miscues was longer than that of other words. In reality, reader ''carelessness'' with visual inspection of words is not the cause of these substitution miscues (Paulson, 2002).

Maria's performance is no different than what has been reported in the literature on normal readers. She fixated on all (100%) of the words in Spanish and English that were realized as a substitution miscue. Returning to Figure 1, an illustration of this behaviour is presented. Maria produces the nonsense word substitution of ''pickid'' for ''peeked''. However, this word receives not one but two fixations (fixations 5 and 6). This pattern was observed throughout Maria's oral reading.

From the intervention perspective, if the reader who produces substitution miscues has already carefully examined the miscued word, is it productive to direct them back to the word for closer visual inspection when the miscue is observed? The reality that miscued words are, more often than not, fixated suggests that the issue is not one of faulty visual sampling. Instead, data from Maria, as well as data presented in the literature, suggest that meaningfulness most plausibly drives the production of substitution miscues. Therefore, when readers produce miscues would it not be more advisable to provide strategies that assist the reader in establishing meaning (Paulson & Freeman, 2003)? Based upon the physiological data, such an approach represents a more defensible option.

Caveats for implications

This research report considers two misconceptions and demonstrates from the literature as well as on going research the reality of these misconceptions. These findings stand to have a significant impact on the clinical practices for children with impairment and reading difficulties. Although these EMMA data reveal a consistency between this participant and many other participants in other reading studies, the data are restricted to only one exceptional reader. Additional data are currently being collected. It will be important to consider this exceptional reader's behaviours on other texts from different genre in order to more fully see how she makes sense of print across contexts. Finally, it is not known exactly what impact her reading instruction prior to this point had on her eye movement and miscue behaviours. In spite of these limitations, the authentic nature of the reading selections and data collection procedures did allow application of eye movement miscue analysis to this child with language impairment.

References

Arnold, T. (1999). *Huggly Gets Dressed*. New York: Scholastic.

Adams, M. (1990). *Beginning to Read: Thinking and Learning about Print*. Cambridge, MA: MIT Press.

Adams, M., & Bruck, M. (1995). Resolving the "Great Debate". *American Educator*, *19*, 10–20.

Bruner, J. S. (1957). Going beyond the information given. In H. Gruber et al. (Eds.), *Contemporary Approaches to Cognition: a Symposium Held at the University of Colorado*. Cambridge, MA: Harvard University Press.

Duckett, P. (2001). *First Grade Beginning Readers' Use of Pictures and Print as They Read: a Miscue Analysis and Eye Movement Study*. Ann Arbor, MI: UMI Dissertation Services.

Duckett, P. (2003). Envisioning Story: the Eye Movements of Beginning Readers. *Literacy Teaching and Learning*, *7*, 77–89.

Freeman, A. (2001). *The Eyes Have It: Oral Miscue and Eye Movement Analysis of Reading of the Fourth Grade Spanish/English Bilinguals*. Ann Arbor, MI: UMI Dissertation Services.

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

Goodman, K. (1996). *On Reading: A Common-sense Look at the Nature of Language and the Science of Reading*. Portsmouth, NH: Heinemann.

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, NY: Robert C. Owens Publishers.

Gough, P. (1972). One second of reading. In J. F. Kavanagh & I. G. Mattingly (Eds.), *Language by Ear and by Eye: the Relationships between Speech and Reading* (pp. 331–358). Cambridge, MA: MIT Press.

Hogaboam, T. (1983). Reading patterns in eye movement data. In K. Rayner (Ed.), *Eye Movements in Reading* (pp. 309–332). New York, NY: Academic Press.

Huey, E. (1908). *The Psychology and Pedagogy of Reading*. Cambridge, MA: MIT Press.

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

Lyon, G. (1999). In celebration of science in the study of reading development, reading difficulties, and reading instruction: the NICHD Perspective. *Issues in Education: Contributions from Educational Psychology*, *5*, 85–115.

Mayer, M. (1983). *Mi Abuela y yo*. Racine, WI: Western Publishing Company Inc.

Moats, L. C. (1999). *Teaching Reading Is Rocket Science*. Washington, DC: American Federation of Teachers.

National Reading Panel (2000). *Teaching Children to Read: an Evidence-based Assessment of the Scientific Research Literature on Reading and Its Implications for Reading Instruction*. Washington, DC: National Institute of Child Health and Human Development.

Paulson, E. (2000). *Adult Readers' Eye Movements during the Production of Oral Miscues*. Ann Arbor, MI: UMI Dissertation Services.

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

Paulson, E. (2005). Viewing eye movements during reading through the lens of Chaos Theory: how reading is like the weather. *Reading Research Quarterly*, *40*, 338–358.

Paulson, E., & Goodman, K. (1999, January). Influential Studies in Eye-Movement Research. Reading Online (Retrieved October 20, 2006), from http://www.readingonline.org/research/eyemove.html.

Paulson, E., & Freeman, A. (2003). *Insight from the Eyes: the Science of Effective Reading Instruction*. Portsmouth, NH: Heinemann.

Paulson, E., Flurkey, A., Goodman, Y., & Goodman, K. (2003). Eye movements and miscue analysis: reading from a constructivist perspective. *National Reading Conference Yearbook*, *52*, 345–355.

Paulson, E., & Henry, J. (2002). Does the degrees 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.

Rayner, K., & Pollatsek, A. (1989). The Psychology of Reading. Hillsdale, NJ: Lawrence Erlbaum Associates.

Rayner, K., & Sereno, S. (1994). Eye movement in reading: Psycholinguistic studies. In M. A. Gernsbacher (Ed.), *Handbook of Psycholinguistics* (pp. 57–81). San Diego, CA: Academic Press.

Rayner, K., & Well, A. (1996). Effects of contextual constraint on eye movement in reading: a further examination. *Psychonomic Bulletin and Review*, *3*, 504–509.

Smith, F. (2004). *Understanding Reading*. Sixth Edition. Mahwah, NJ: Lawrence Erlbaum Associates.

Swank, L., & Catts, H. (1994). Phonological awareness and written word decoding. *Language, Speech, and Hearing Services in Schools*, *25*, 9–14.

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

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