

This article was downloaded by: [212.78.216.54]

On: 24 June 2015, At: 13:23

Publisher: Routledge

Informa Ltd Registered in England and Wales Registered Number: 1072954 Registered office: Mortimer House, 37-41 Mortimer Street, London W1T 3JH, UK



[Click for updates](#)

Journal of Cognitive Psychology

Publication details, including instructions for authors and subscription information:

<http://www.tandfonline.com/loi/pecp21>

Emerging issues in developmental eye-tracking research: Insights from the workshop in Hannover, October 2013

Simon P. Liversedge^a, Sascha Schroeder^b, Jukka Hyönä^c & Keith Rayner^d

^a School of Psychology, University of Southampton, Highfield Campus, SO17 1BJ Southampton, UK

^b Department of Psychology, Max Planck Institute, Berlin, Germany

^c Department of Psychology, University of Turku, Turku, Finland

^d Department of Psychology, University of California, San Diego, La Jolla, CA, USA

Published online: 24 Jun 2015.

To cite this article: Simon P. Liversedge, Sascha Schroeder, Jukka Hyönä & Keith Rayner (2015) Emerging issues in developmental eye-tracking research: Insights from the workshop in Hannover, October 2013, *Journal of Cognitive Psychology*, 27:5, 677-683, DOI: [10.1080/20445911.2015.1053487](https://doi.org/10.1080/20445911.2015.1053487)

To link to this article: <http://dx.doi.org/10.1080/20445911.2015.1053487>

PLEASE SCROLL DOWN FOR ARTICLE

Taylor & Francis makes every effort to ensure the accuracy of all the information (the "Content") contained in the publications on our platform. However, Taylor & Francis, our agents, and our licensors make no representations or warranties whatsoever as to the accuracy, completeness, or suitability for any purpose of the Content. Any opinions and views expressed in this publication are the opinions and views of the authors, and are not the views of or endorsed by Taylor & Francis. The accuracy of the Content should not be relied upon and should be independently verified with primary sources of information. Taylor and Francis shall not be liable for any losses, actions, claims, proceedings, demands, costs, expenses, damages, and other liabilities whatsoever or howsoever caused arising directly or indirectly in connection with, in relation to or arising out of the use of the Content.

This article may be used for research, teaching, and private study purposes. Any substantial or systematic reproduction, redistribution, reselling, loan, sub-licensing, systematic supply, or distribution in any form to anyone is expressly forbidden. Terms & Conditions of access and use can be found at <http://www.tandfonline.com/page/terms-and-conditions>

Emerging issues in developmental eye-tracking research: Insights from the workshop in Hannover, October 2013

Simon P. Liversedge¹, Sascha Schroeder², Jukka Hyönä³, and Keith Rayner^{4†}

¹School of Psychology, University of Southampton, Highfield Campus, SO17 1BJ Southampton, UK

²Department of Psychology, Max Planck Institute, Berlin, Germany

³Department of Psychology, University of Turku, Turku, Finland

⁴Department of Psychology, University of California, San Diego, La Jolla, CA, USA

This paper provides a summary of the main issues that arose in the final “Discussion” session at the Volkswagen Workshop on Developmental Eye-tracking Research in Reading held in Hannover, Germany, October 2013. The Workshop focused on eye movement research investigating reading development, that is, change in reading performance with age. Development was considered both in relation to children as they changed from novice to more efficient readers, as well as change in reading performance in older adult readers, usually associated with a decline in reading efficiency. The final Discussion session provided an opportunity for attendees to comment on, discuss, and debate any issues that arose in the meeting that they felt were important.

Keywords: Development; Eye Movements; Workshop Discussion.

In this paper we will provide a brief summary of the methodological and theoretical issues that emerged out of the Volkswagen Workshop on Developmental Eye-tracking Research in Reading. This event was held in Hannover, Germany, October 2013 and was the first workshop of its kind. As the name suggests, the primary theme was the consideration of eye movement research investigating reading development. The topic of reading development was taken to cover both changes in reading performance that occurred during the period of childhood to adulthood

(representing a shift towards increased efficiency in reading) as well as during the older adult years (generally marked by a decline in reading efficiency). The workshop was sponsored by the Volkswagen Foundation and took place in the Schloss Herrenhausen. Forty-two people attended the meeting and the profile of the attendees was purposefully mixed in relation to experience, ranging from early career researchers (ECRs; post-graduate students and postdoctoral researchers) through to very experienced researchers (world leading professorial researchers). All the attendees

Correspondence should be addressed to Simon P. Liversedge, School of Psychology, University of Southampton, Highfield Campus, Southampton SO17 1BJ, UK. E-mail: s.p.liversedge@soton.ac.uk

No potential conflict of interest was reported by the authors.

This work was supported by the Volkswagen Foundation [grant number 87191].

[†]Due to illness, Keith Rayner was unable to attend the Workshop in Hannover in person. However, he contributed remotely to the discussion session, and provided significant input to this paper in the months following the Workshop. Keith passed away in January 2015.

were active in the emerging research area of eye movements and reading development. Whilst some of the attendees were invited to take part in the meeting, others were selected on the basis of submitted abstracts. In this sense the workshop was open to all, though the available slots were allocated to the most relevant and interesting work as determined by the organisers. The workshop was designed to ensure that ECRs were central to proceedings (two important components of the schedule were an ECR poster session and a structured ECR group exercise). The feedback that the organisers received during and after the workshop was uniformly positive, and the consensus view was that the event was very useful and important, and arguably, groundbreaking.

The final session of the workshop was a “Discussion” session that was led by the organisers, Schroeder, Hyönä, and Liversedge. It was anticipated that Keith Rayner would join the organisers in this task; however, unfortunately, due to ill health, Keith was unable to travel, and therefore, contributed to the session structure and content remotely via Skype and email. The purpose of the discussion session was to systematically work through the major issues that had cropped up throughout the workshop. In this sense, it was a kind of summary session representing the key points that had appeared during presentations, debate, and question/answer sessions. The purpose of this concluding paper in the Special Issue is to reflect the content of this discussion session. We felt that the issues and arguments that are described later were important. Often they were issues without an outcome, and sometimes the discussion centred around a question for which there was no immediate, obvious answer, or to which there were differing views in relation to a response across the group of attendees. We have tried to reflect this wherever possible.

During the Discussion session, the organisers gave a brief presentation of the issues that they felt had emerged during the Workshop—this provided the basis for further, extended, discussion. The final session also represented a “free floor” forum in which the points that were raised could be expanded upon and clarified, moving beyond the initial presentation of the issues. Perhaps the most overriding point that came to the fore during the entire discussion was that there was recognition of the fact that this area of eye movement research is in its formative stages, and researchers are still exploring the best ways to use methodological paradigms and analytical tools to understand

changes in reading performance with age. Also, at some level, this acknowledgement represents an admission that, at present, as a group of researchers, we have not currently refined our experimental approach such that it is optimal for tackling theoretical questions in the field of developmental reading research. Arguably, this statement is perhaps too strong. However, it is a veridical reflection of the consensus view to state that there are certainly aspects of current experimental practice in this area that we could be doing better.

The field of eye movement research investigating reading is well established (see Rayner, 1998, 2009). However, as has been documented (e.g., Blythe & Joseph, 2011), the majority of eye movement studies investigating reading have focused on skilled adult reading, with far less research investigating the nature of change in reading performance with age. Of course, there are a small number of early studies investigating reading development that have documented basic aspects of reading performance in younger populations (e.g., Buswell, 1922; McConkie et al., 1991; Rayner, 1986; Taylor, 1966). However, more recently, with developments in the usability and availability of eye movement recording systems, and broader recognition that eye movements provide an excellent index of online processing during reading (e.g., see Rayner & Liversedge, 2004), there has been increased interest in obtaining eye movement data from children and older adults to investigate how eye movement behaviour during reading changes as children learn to read, and as reading performance declines with age. Consequently, in recent years, there has been significant expansion in the amount of research that is being carried out in this area, and recently quite a number of published papers have started to appear in the literature. Our sense is that this area of research will continue to expand into the future, and the current Special Issue serves to formally acknowledge this shift. Given this context, the workshop was felt to be timely, offering for the first time, an opportunity for developmental eye movement research into reading to be identified as a demarcated research area in and of itself. In the remainder of this paper, we will detail the eight issues that emerged in the discussion session of the workshop.

ORAL VERSUS SILENT READING

One of the first issues that arose in relation to children’s reading development was the

relationship between silent and oral reading. When children start to learn to read, they orally spell out words letter by letter and in this way form links between orthographic form and phonological forms. This is a critical, early, aspect of the learning process (Rayner, Foorman, Perfetti, Pesetsky, & Seidenberg, 2001; Share, 1995). As reading becomes more proficient, children become able to read phrases, sentences and passages out aloud, and indeed, reading performance is most often assessed (educationally) on the basis of the words a child speaks as they read and the forms of phonological errors that they make. As the child develops further, they usually become able to read silently and effectively without speaking. The inner voice that is often alluded to in reading research, but is little understood, is likely the mental replacement for the physical act of uttering the words aloud during reading. Importantly, almost exclusively, when eye movement experiments investigating children's reading are carried out, it is the adult-like performance of silent reading that is most often measured. Two points immediately arise when considering the relationship between silent and oral reading. First, the standard eye-tracking paradigms that we ordinarily use to investigate adult reading are used to investigate silent reading, and therefore these techniques are limited to investigations of the latter stages of children's reading development. It is clear that a significant amount of developmental change precedes this stage, and it seems unlikely that standard eye movement research to investigate reading will be useful. It can be argued, therefore, that this constitutes quite a severe limitation of standard eye movement methodology. The use of more innovative methods (e.g., see Laishley, Liversedge, & Kirkby, 2015, in the Special Issue for a novel use of eye-tracking methodology to explore aspects of early reading and writing development) will likely be necessary to investigate earlier phases of children's reading development (see Vorstius, Radach, & Lonigan, 2014, for a study comparing oral and silent reading in developing readers). The second point concerns the suggestion that the inner voice is essentially a replacement aspect of processing for vocalisation that occurs during reading aloud. If this suggestion is correct, then a critical issue concerns the role of the inner voice during reading (particularly in relation to phonological processing; see Ashby, 2010; Ashby, Dix, Bontrager, Dey, & Archer, 2013). However, at present there has been very little work to investigate the role that the inner

voice plays in reading, and as indicated earlier, our understanding of this area is currently very limited (but see, e.g., the study by Häikiö, Bertram, & Hyönä, 2015, in the Special Issue). Clearly, this is an area that requires significant attention in future research.

CROSS-LINGUISTIC COMPARISONS

The second issue that arose in the discussion session concerned the extent to which there is value in undertaking cross-linguistic developmental research. This question was raised both in relation to changes in older adult reading as well as in relation to children's reading development. Specifically, there was interest, and indeed, a significant degree of optimism regarding whether a cross-linguistic approach might provide insight into how factors such as the orthographic depth, alphabetic status, and morphological (and other linguistic) characteristics of different languages impact on change during development (see Feng, Miller, Shu, & Zhang, 2009; Rau, Moll, Snowling, & Landerl, 2015, for two recent studies comparing children learning to read in different orthographies). It is our understanding that at present, there are at least two or three, ongoing longitudinal cross-linguistic research projects investigating children's reading development. No doubt, these will be very fruitful in informing understanding. In contrast, to our knowledge, at present there are no such projects investigating changes in reading efficiency in older adults.

As an aside, it is worth noting that a number of concerns were raised in relation to the pragmatic difficulties associated with running cross-linguistic studies. Specifically, establishing equivalence in linguistic stimuli across languages, particularly in alphabetic languages compared to non-alphabetic languages is difficult. Evaluating how participant group differences (e.g., differences in the amount of formal education received at given ages, nursery/home tuition, differences in literacy policies across countries, etc.) contribute to cross-linguistic differences in reading is extremely difficult. Also, management of international projects is often harder than management of domestic projects. Finally, the long-standing, and non-trivial, issue of how funding might be secured to support such large-scale international projects arose.

INDIVIDUAL DIFFERENCES

Differences in reading development across populations also arose as a topic for discussion in more general terms, that is, beyond questions of cross-linguistic investigation. The group discussed the issue of categorisation in relation to individual differences in reading development, and the identification of specific subgroups with unique, and potentially defining, characteristics. Again, this issue is relevant to changes in both older adult reading as well as children's reading. It was argued that because eye-tracking methodology offers a very precise, online measure of processing in reading, it may prove to be a more incisive tool in identifying defining characteristics in relation to both older and younger developmental subgroups. Whilst speculative, this possibility is exciting. Furthermore, it was very generally recognised that an individual differences perspective on reading development should form a very central approach to future research. Indeed, as the studies by Joseph, Bremner, Liversedge, and Nation (2015), Sperlich, Schad, and Laubrock (2015), and Mancheva et al. (2015) show individual differences studies feature prominently in this Special Issue.

METHODOLOGICAL EYE-TRACKING ISSUES (EYE-CONTINGENT CHANGE METHODS)

The next broad topic of focus concerned methodological issues associated with assessing changes in reading performance in children and older adults. A very specific, but central question that arose concerned the use of eye-contingent change methods such as the moving window technique and the boundary paradigm (McConkie & Rayner, 1975; Rayner, 1975) with children and older adult participants. The shared view in the discussion session was that it is possible to use such techniques effectively—indeed, one or two experimental studies have been recently published or are currently progressing through the publication process (e.g., Blythe, Häikiö, Bertam, Liversedge, & Hyönä, 2011; Jordan, McGowan, & Paterson, 2014; Rayner, Yang, Castelhan, & Liversedge, 2011). This interest is also represented in the contributions to the Special Issue (see the studies by Marx, Hawelka, Schuster, & Hutzler, 2015; Sperlich et al., 2015; Tiffin-Richards & Schroeder, 2015). Thus, it is clearly the case that the saccadic

eye movements of children and older adults can serve to trigger contingent change manipulations in much the same way that adult proficient readers' saccadic eye movements trigger changes. A much more important question that was raised, however, concerned whether an effect associated with a contingent change manipulation in children or older adults, reflected the same aspects of processing as it did in standard adult populations. For example, does a 20 ms boundary paradigm preview effect in adults reflect similar aspects of processing as a 20 ms preview effect in children, or in older adults? To be more concrete, do comparable effects using similar paradigms in different populations reflect similar, or instead, qualitatively different, aspects of processing? This seems to be a critical issue fundamentally bound to the nature of theoretical descriptions of reading at different points of development. It may well be the case that a significant degree of experimental work is required in order to develop a clearer understanding of the answer to this question.

COMPUTATIONAL MODELLING

Another issue that was uniformly felt to be important, is that computational models of eye movement control during reading, and models of the cognitive processes underlying reading, should be extended in parallel with experimental work to account for the nature of developmental change. It was the consensus view that computational modelling is critical in order to constrain and structure theoretical development in the area of reading and eye movement control (see the study by Mancheva et al., 2015, in the Special Issue). This applies to developmental work as readily as it does to non-developmental work in this area.

CORPUS STUDIES VERSUS THE EXPERIMENTAL METHOD

The next point that was discussed in the session raised some disagreement. Quite a number of attendees at the workshop advocated the use of large data-sets, and proponents of this approach felt that this was certainly the direction in which to go with work in this area. In particular, it was felt that large data-sets, corpus analyses, and statistical analytical techniques such as linear mixed modeling and other advanced approaches were all valuable. It is a fair assessment to say that

this was a broad and strongly held view amongst a significant proportion of the attendees. However, it was also the case that there was an equally vocal contingent within the workshop who favoured a more traditional experimental approach to research in this area, specifically, well-controlled experiments with orthogonally manipulated variables. This group of researchers felt that this latter approach lends itself much more readily to a predictive approach, whereby a-priori hypothesis generation on the basis of theory and formal computational models is central to the scientific process. Through the manipulation of a smaller number of variables, and consequently, with statistical models containing fewer variables, it was argued that this alternative approach offered the possibility of greater precision in formal hypothesis generation and testing. Overall, it is likely that both approaches each have their relative strengths and weaknesses, and the complementary adoption of the two together will likely prove most fruitful for developmental research. As a consequence, experimental (e.g., Liang et al., 2015; McGowan, White, & Paterson, 2015) as well as correlational studies were included in the Special Issue (e.g., Mancheva et al., 2015; Sperlich et al., 2015).

STATISTICAL MODELS

Before leaving this discussion of how to structure empirical investigation within this area, it is also worth mentioning that serious consideration was also given to the topic of how researchers might think more flexibly about structuring statistical models of developmental data. It was felt that with recent advances in statistical techniques, there is now greater possibility for thinking more flexibly about the model space, and exactly how statistical models capture variability within that space in relation to issues of development. For example, specifically, and in relation to theoretical perspective, it could be productive to consider qualitatively different statistical models of performance as reflecting different stages, or even states, of development. The idea of shifts between qualitatively different model states as a reflection of developmental change was generally regarded as a particularly exciting possibility, and at a meta-theoretical level, might be considered alongside the relationship between reading development and automaticity, something that itself was

identified as very important (e.g., Logan, 1997; Samuels & Flor, 1997).

PURE BASIC RESEARCH AND EDUCATIONAL APPLICATIONS

The final significant topic that gained attention in the discussion session of the workshop concerned the relationship of developmental eye movement research with more applied educational research investigating issues of literacy development. Of course, research investigating how children learn to read, rather than work investigating reading decline in older adults was primarily relevant here. It was noted that throughout the workshop presentations and discussions, the word “literacy” had cropped up very rarely, and it was suggested that this reflected the fact that researchers in this area, for some reason, often felt that their work did not align particularly readily with research (often described as investigating literacy development. Consistent with this suggestion, it was noted that attendees at the workshop would most likely attend mainstream experimental psychology conferences such as the Psychonomic Society Annual Meeting, and the European Conference on Eye Movements, rather than conferences with a more educational focus such as the Society for the Scientific Study of Reading. It was felt that this tendency might reflect a somewhat narrow perspective on the research area. The fundamental distinction between basic and applied research in developmental research investigating reading is a core issue, and it seems likely that to make current research more impactful, and therefore, potentially, more fundable, it could be helpful to adopt a less rigid distinction between the two approaches. It was also broadly felt that there was a real necessity to engage with issues of application in this area (and the studies by Häikiö et al., 2015; Kaakinen, Lehtola, & Paattilampi, 2015, in the Special Issue are very good examples for this approach).

SUMMARY

In summary, in this paper we have tried to convey the ideas and debates that came to the fore in the final discussion session of the Workshop on Developmental Eye-tracking Research in Reading (October 2013). Those discussions focused on theoretical and empirical points that were felt to be important and relevant to current and future

developmental eye movement research investigating reading. The level of enthusiasm and energy for these discussions, and for the Workshop more generally, in our view, reflects the increasing interest in this area of research.

REFERENCES

- Ashby, J. (2010). Phonology is fundamental in skilled reading: Evidence from ERPs. *Psychonomic Bulletin & Review*, *17*, 95–100. doi:10.3758/PBR.17.1.95
- Ashby, J., Dix, H., Bontrager, M., Dey, R., & Archer, A. (2013). Phonemic awareness contributes to text reading fluency: Evidence from eye movements. *School Psychology Review*, *42*, 157–170.
- Blythe, H. I., & Joseph, H. S. S. L. (2011). Children's eye movements during reading. In S. P. Liversedge, I. D. Gilchrist, & S. Everling (Eds.), *The Oxford handbook of eye movements* (pp. 643–662). Oxford: Oxford University Press.
- Blythe, H. I., Häikiö, T., Bertam, R., Liversedge, S. P., & Hyönä, J. (2011). Reading disappearing text: Why do children refixate words? *Vision Research*, *51*(1), 84–92. doi:10.1016/j.visres.2010.10.003
- Buswell, G. T. (1922). *Fundamental reading habits: A study of their development*. Chicago: University of Chicago Press.
- Feng, G., Miller K., Shu, H., & Zhang, H. (2009). Orthography and the development of reading processes: An eye-movement study of Chinese and English reading development. *Child Development*, *80*, 720–735. doi:10.1111/j.1467-8624.2009.01293.x
- Häikiö, T., Bertrand, R., & Hyönä, J. (2015). The role of syllables in word recognition among beginning Finnish readers: Evidence from eye movements during reading. *Journal of Cognitive Psychology*, *27*, 562–577. doi:10.1080/20445911.2014.982126
- Jordan, T. R., McGowan, V. A., & Paterson, K. B. (2014). Reading with filtered fixations: Age differences in the effectiveness of low-level properties of text within central vision. *Psychology and Aging*, *29*, 229–235. doi:10.1037/a0035948
- Joseph, H. S. S. L., Bremner, G., Liversedge, S. P., & Nation, K. (2015). Working memory, reading ability and the effects of distance and typicality on anaphor resolution in children. *Journal of Cognitive Psychology*, *27*, 622–639. doi:10.1080/20445911.2015.1005095
- Kaakinen, J. K., Lehtola, A., & Paattilampi, S. (2015). The influence of a reading task on children's eye movements during reading. *Journal of Cognitive Psychology*, *27*, 640–656. doi:10.1080/20445911.2015.1005623
- Laisley, A., Liversedge, S. P., & Kirkby, J. (2015). Lexical processing in children and adults during word copying. *Journal of Cognitive Psychology*, *27*, 578–593. doi:10.1080/20445911.2014.991396
- Liang, F., Blythe, H. I., Zang, C., Bai, X., Yan, G., & Liversedge, S. P. (2015). Positional character frequency and word spacing facilitate the acquisition of novel words during Chinese children's reading. *Journal of Cognitive Psychology*, *27*, 594–608. doi:10.1080/20445911.2014.1000918
- Logan, G. D. (1997). Automaticity and reading: Perspectives from the instance theory of automatization. *Reading and Writing Quarterly*, *13*, 123–146. doi:10.1080/1057356970130203
- Mancheva, L., Reichle, E. D., Lemaire, B., Valdois, S., Ecalle, J., & Guérin-Dugué, A. (2015). An analysis of reading skill development using E-Z Reader. *Journal of Cognitive Psychology*, *27*, 657–676. doi:10.1080/20445911.2015.1024255
- Marx, C., Hawelka, S., Schuster, S., & Hutzler, F. (2015). An incremental boundary study on parafoveal preprocessing in children reading aloud: Parafoveal masks overestimate the preview benefit. *Journal of Cognitive Psychology*, *27*, 549–561. doi:10.1080/20445911.2015.1008494
- McConkie, G. W., & Rayner, K. (1975). The span of the effective stimulus during a fixation in reading. *Perception & Psychophysics*, *17*, 578–586.
- McConkie, G. W., Zola, D., Grimes, J., Kerr, P. W., Bryant, R. B., & Wolff, P. M. (1991). Children's eye movements during reading. In J. F. Stein (Ed.), *Vision and visual dyslexia* (pp. 251–262). London: The Macmillan Press.
- McGowan, V. A., White, S. J., & Paterson, K. B. (2015). The effects of interword spacing on the eye movements of young and older readers. *Journal of Cognitive Psychology*, *27*, 609–621. doi:10.1080/20445911.2014.988157
- Rau, A. K., Moll, K., Snowling, M. J., & Landerl, K. (2015). Effects of orthographic consistency on eye movement behavior: German and English children and adults process the same words differently. *Journal of Experimental Child Psychology*, *130*, 92–105. doi:10.1016/j.jecp.2014.09.012
- Rayner, K. (1975). The perceptual span and peripheral cues in reading. *Cognitive Psychology*, *7*, 65–81. doi:10.1016/0010-0285(75)90005-5
- Rayner, K. (1986). Eye movements and the perceptual span in beginning and skilled readers. *Journal of Experimental Child Psychology*, *41*, 211–236.
- Rayner, K. (1998). Eye movements in reading and information processing: 20 years of research. *Psychological Bulletin*, *124*, 372–422.
- Rayner, K. (2009). The thirty fifth Sir Frederick Bartlett Lecture: Eye movements and attention during reading, scene perception, and visual search. *Quarterly Journal of Experimental Psychology*, *62*, 1457–1506.
- Rayner, K., Foorman, B. R., Perfetti, C. A., Pesetsky, D., & Seidenberg, M. S. (2001). How psychological science informs the teaching of reading. *Psychological Science in the Public Interest*, *2*, 31–74. doi:10.1111/1529-1006.00004
- Rayner, K., & Liversedge, S. P. (2004). Visual and linguistic processing during eye fixations in reading. In J. M. Henderson & F. Ferreira (Eds.), *The interface of language, vision, and action: Eye movements and the visual world* (pp. 59–104). Hove: Psychology Press.
- Rayner, K., Yang, J., Castelano, M. S., & Liversedge, S. P. (2011). Eye movements of older and younger readers when reading disappearing text. *Psychology and Aging*, *26*, 214–223. doi:10.1037/a0021279
- Samuels, S. J., & Flor, R. F. (1997). The importance of automaticity for developing expertise in reading.

- Reading and Writing Quarterly*, 13, 107–121. doi:10.1080/1057356970130202
- Share, D. L. (1995). Phonological recoding and self-teaching: sine qua non of reading acquisition. *Cognition*, 55, 151–218. doi:10.1016/0010-0277(94)00645-2
- Sperlich, A., Schad, D. J., & Laubrock, J. (2015). When preview information starts to matter: Development of the perceptual span in German beginning readers. *Journal of Cognitive Psychology*, 27, 511–530. doi:10.1080/20445911.2014.993990
- Taylor, E. A. (1966). *The fundamental reading skill*. Springfield, IL: Charles C Thomas.
- Tiffin-Richards, S. P., & Schroeder, S. (2015). Children's and adults' parafoveal processing in German: Phonological and orthographic effects. *Journal of Cognitive Psychology*, 27, 531–548. doi:10.1080/20445911.2014.999076
- Vorstius, C., Radach, R., & Lonigan, C. J. (2014). Eye movements in developing readers: A comparison of silent and oral sentence reading. *Visual Cognition*, 22, 458–485. doi:10.1080/13506285.2014.881445