THOUGHTS ON THE RESEARCH OF THE READING/VISION ASSOCIATION

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Abstract

The interface between optometry and ophthalmology concerning the role vision plays in reading remains discordant. This paper examines the topic and discusses several aspects of related research which may not be familiar to all optometrists and ophthalmologists. The conclusion is drawn that the search for simple associations between particular facets of visual anomalies and reading difficulty constitutes an inadequate experimental design in both causal and remedial aspects. This weakness in design is especially relevant when unselected samples of good and bad readers constitute the subjects. The discussion is supported by analogy with other complex problems, such as adverse responses to therapeutic drugs and prescriptive/diagnostic treatment for dry eye conditions.

Key Words

diagnostic/prescriptive approach, indeterminism, optometry, ophthalmology, research, reading, statistical significance

Introduction

Dr Goldberg's response[1] to Leonard Press' article[2] that was published in a recent edition of the Journal of Behavioral Optometry appears to derive, in part, from a misunderstanding of research that examines the relationship between vision and reading. Dr. Goldberg may be inclined to accept, without qualification, the results of investigations that fail to find an association between vision deficits and reading difficulty. This misunderstanding is apparent in the optometric, as well as in the ophthalmological literature, and arises in part from the acceptance of inappropriate research designs that examine the relationship between vision and reading. Often poor design leads to finding either no or limited statistical significance between vision and reading. However, there is a need to distinguish between clinical and statistical significance. For example, sometimes research shows a statistically significant difference between experimental samples that is unlikely to have any clinical significance.[3] More commonly, the reverse is the case: a study may fail to find a significant association between suspected causal factors and a particular condition, but this does not necessarily mean that there isn't clinical significance. Indeed, much of effective optometric and ophthalmological practice is performed without a foundation of statistical significance.

Statistical Significance Pitfalls in Research

Lack of statistical significance may be due to sample sizes being too small. Lack of statistical significance may result from the hypothesis examined being unrealistically framed. For example, some clinical responses to medications are due to complex interactions between concurrent therapies, the diseases being treated and patient compliance. If the study examines for statistical significance of adverse reactions for each drug, it may fail to find statistically significant effects if, in an unselected sample, the possibility of drug interactions is not considered. The study may fail to find adverse symptoms due to drug interactions because the same symptoms are associated with one of the diseases being treated. The study may fail to show statistical significance because the adverse response only occurs in individuals taking higher dosages, who represent a minority of the sample examined. The sample may include subjects who are not compliant in using both of the potentially interactive medications. In addition, the sample may be unselected in that it includes subjects who are using the medications for a diverse range of diseases, when the adverse interaction is specific to a particular disease. Although a simple experimental design that does not account for these issues is less likely to find a statistically significant association, there is nevertheless a clinical significance for the subjects who suffer an adverse response.

Unfortunately, lack of statistical significance due to weakness in experimental design may be used to deny the relevance of findings that are clinically significant.[1]

Examination of the relationship between vision and reading reveals a similar complexity. The reading disabled population includes children (and adults) with a great variety of deficits, so that group means for particular deficits will tend to be depressed.[4] This comment does not solely refer to the wide variety of vision deficits that may contribute to reading difficulty, but rather to the much wider range of deficits, including vision, that are known to be, or are suspected of being, associated with reading problems. These deficits include, for example, low intelligence, low socio-economic status, neurobehavioral dysfunction,[4] previous remedial intervention, degree of behavioral disturbance, attention-concentration and hyperactivity.[5] Attempts to find statistically significant associations between vision anomalies and reading ability may not be successful because of the difficulty in controlling for the complex interaction between vision anomalies, and the many other variables that might influence reading performance. One of the problems is that these same anomalies or deficits are found among successful readers who are apparently fortunate to have strengths that enable them to overcome these barriers. When comparisons are made between samples of good and poor readers, the presence of compensated deficits among good readers will weaken any association between those deficits and poor readers. Thus, potentially confounding variables should be taken into account in the interest of sound research.[6]

For example, dysfunctional accommodation may not appear to be significant in a child with high intelligence, interested parents, the benefit of individualized teaching, a wide range of reading materials or other strengths to help them overcome difficulty in sustaining near focus. For children lacking such compensatory strengths, accommodative dysfunction may contribute to their reading difficulty. It would be very difficult to show an association between reading difficulty and dysfunctional accommodation without controlling for the many other possible contributory and compensatory factors.

A case in point

A study by Kiely, Crewther and Crewther, 'Is there an association between functional vision and learning to read?'[7] is an example of the hazards that arise from the use of an inappropriate experimental design. The authors examined a complex subject that has been previously investigated,[8,9] frequently using a similar inappropriate experimental design. They measured a range of functional vision components in samples of children with and without reading difficulty. They sought simple associations between individual aspects of functional vision and reading difficulty.

One question that the authors raised was whether accommodative dysfunction could be shown to be a contributory factor in a comparison of an unselected sample of children with reading difficulty with an unselected sample of good readers. The complex heterogeneous nature of reading difficulties suggests otherwise and the results obtained from the study by Kelly, Crewther and Crewther[7] might have been anticipated. Thus, accommodative dysfunction may not be as important to a beginning reader with a capacity to acquire whole word recognition ability, and other skills that permit a "top down" method of reading. A faster speed of reading by this method is likely to facilitate comprehension. Success in reading, and the associated satisfaction and enjoyment, might be motivating too, with voluntary reading increased accordingly. Progression toward higher reading skill levels may be more easily achieved under these circumstances, despite accommodative dysfunction. However, accommodative dysfunction in a child who does not have a capacity to develop a whole-word recognition ability, or other skills required for "top down" reading, may be more significant. In this case, reading may involve a "bottom up" reading style with careful analysis of words as identification of phonetic components is attempted. A slower, more detailed approach to word recognition could act as a barrier to comprehension. Longer periods required to cover the same amount of text appear likely to be more demanding of sustained accommodative function. Because the "bottom up" mode of reading can demand greater perseverance, a beginning reader using this method may be more likely to be adversely affected by accommodative dysfunction that reduces the reader's ability to persevere with the reading task. Any difficulty in learning to read could be compounded by lack of satisfaction and enjoyment, and an associated reduced willingness to read voluntarily. This child may prefer activities that don't involve detailed close vision and accommodative stress. In the absence of compensatory skills, and especially in the presence of deficits other than accommodative dysfunction, reading progress can be slow for this type of child, despite excellent and prolonged remedial teaching efforts.

The subsequent restatement and comments on their paper by Kiely, Crewther and Crewther discusses a trend they found indicating that poor readers were more likely to exhibit low findings on a test of accommodative facility.[10] Perhaps that trend would have become statistically significant if their sample sizes were larger, or their samples were selected appropriately. They might have examined the significance of accommodative dysfunction by selecting a subset from their samples on the basis of complaints of intermittent blur, headaches and/or eyestrain when reading. This more relevant sample could also have included symptom-free children who have good attention skills except during near focus activities. In addition, instead of examining accommodative dysfunction separately, they might have examined it in combination with convergence insufficiency and other anomalies of binocular vision that can impair near vision. Seeking a simple association asks the question: 'Could accommodative dysfunction alone, be such a strong and common cause of reading difficulty that it would be significantly different for unselected samples of good and poor readers?' A better question could be: 'Is accommodative dysfunction a contributing factor in children with reading difficulty who have problems maintaining concentration when reading, and who lack compensatory strengths?' This is a much harder question to answer , but the difficulty factor cannot justify using simpler methods unless it is made clear that not all factors were accounted for in the study. This would have a profound effect on the conclusions.

However, even if a statistically significant correlation between reading difficulty and dysfunctional accommodation were found, it wouldn't necessarily mean

that the association is causal. Such a finding could be an indication that accommodative facility develops better in competent readers, because of the greater amount of close work performed by this group. Perhaps reading difficulty and accommodative dysfunction vary with both being the result of genetics.[11] Nevertheless, if either of these circumstances did apply, it would not exclude the possibility that treatment for dysfunctional accommodation could be a valuable component of a remedial approach. Similarly, uncertainty about the cause of ocular inflammation does not exclude the possibility that cortico-steroid therapy could be a valuable form of treatment.

Another apparently erroneous conclusion that comes from the Kiely, Crewther and Crewther study[7] concerns the association between intelligence and reading. The samples the authors studied included two groups with reading accuracy ages two or more years behind their chronological age. One sample was described as dyslexic and had a non-verbal mental age no greater than one standard deviation below the mean for its age. The other sample was described as learning disabled and had a non-verbal mental age at least one standard deviation below the mean for its age. As a result, while reading levels were not significantly different for the two groups, they were significantly different for non-verbal mental age. The statistical significance of this simple association could be misinterpreted to arrive at the erroneous conclusion that intelligence is not relevant in learning to read.

This study is typical of investigations that use gross comparative sampling techniques and fail to find significant associations between vision factors and reading difficulty. Unfortunately, the authors concluded that their findings support the view of the Committee on Children with Disabilities that was prepared by the American Academy of Pediatrics, American Academy of Ophthalmology and American Association for Pediatric Ophthalmology and Strabismus.[12] The conclusions of a myriad of similar reports have been described as giving rise to a kind of "Alice in Wonderland" situation in which the child slowly disappears, study by study, as each ability or skill is found not to be involved in reading.[8] One response to the difficulty in finding associations between suspected relevant factors and reading difficulty, is to adopt an indeterministic view, that is, one that ignores causality.

Indeterminism vs. the diagnostic/prescriptive approach

When considering treatment, educators may adopt either a diagnostic/prescriptive or an indeterministic model. The diagnostic/prescriptive model seeks to identify the causes of, or contributing factors to reading difficulty so that remedial efforts can be prescriptive or specific for those factors. I have heard this approach pejoratively described as the "medical model." Proponents of a diagnostic/prescriptive approach, work with the understanding that helping a child to become easier to teach is likely to give faster and more durable educational outcomes that are also easier to achieve. For example, teaching phonetic reading sub skills to those children who lack them may be valuable prerequisites for more successful teaching. Similarly, some children (or adults) with reading difficulty will benefit from treatment of accommodative dysfunction that improves their capacity to use their vision without stress when reading.[13] Clinical techniques to improve overall accommodative facility can expand the range of clear and single binocular vision by relieving a too tight association between accommodation and convergence. Improved visual efficiency, and an associated improved ability to persevere with reading tasks, may help children (or adults) to learn to read as well as to read to learn.[13]

However, some educators appear to be overwhelmed by the complexity of a diagnostic/ prescriptive model for managing reading difficulty. Consequently, they have adopted an indeterministic position which eschews the possibility that remediating known or suspected contributing/causal factors could facilitate teaching. Rather than trying to determine causes, indeterminists depend on the "shot-gun approach" of intensive remedial teaching methods.

Pitfalls in researching the efficacy of treatments

The difficulties encountered in researching the treatment of reading difficulty are analogous to those found in researching treatment of other complex heterogeneous conditions such as keratoconus and dry eye. For example, the term dry eye describes a variety of conditions, of diverse origin, which affect the tear film and/or the ocular surface.[14] Many signs and symptoms of dry eye are common to several forms of ocular disease. In addition, other diseases, such as chronic blepharo-conjunctivitis, have symptoms and signs in common with various forms of dry eye.[15]An experimental design for the evaluation of a dry eye treatment might fail to discriminate between different mechanisms that cause dry eye symptoms. Under these circumstances, a treatment that is specific to a particular form of dry eye may be found to be relatively unsuccessful when applied to an unselected sample. For example, an aqueous tear supplement that replaces deficient tear volume is unlikely to be successful when used to treat dry eye associated with mucin deficiency. Dilution of already deficient mucin, following instillation of an aqueous formulation, would tend to exacerbate the condition. This type of 'shot gun' approach to treatment is inappropriate. In order that a study of a treatment, for a specific form of a complex of similar diseases to have a chance of showing statistically significant results, certain conditions may be necessary. For example, the treatment group would need to be selected according to the diagnostic criteria for subjects who suffer from that specific form of the disease complex. Ideally, following a diagnostic/prescriptive methodology, an aqueous formulation would only be administered to a subset of subjects suffering from aqueous deficiency.

The same type of problem could be evident in some remedial approaches to reading difficulty. Thus, a therapeutic regimen could include a broad range of visual perceptual skills that are involved in reading. However, if this regimen is administered to an unselected sample of children with reading problems, the chance and type of success will be limited. The success of this approach will depend on the number of children in the remedial sample who have, as part of their reading problem, visual perceptual deficits of the type that are addressed by the remedial approach used. That is, the non-prescriptive or "shotgun" approach is unproductive for those children who have reading difficulty for any one or more of the many reasons that are unrelated to the remedial approach used. A "shotgun" approach to search for statistically significant deficits that are as-

sociated with reading difficulty is an equally inadequate experimental design as one that seeks to treat dry eye without ascertaining the specific form of the disease.

Conclusion

The optometrist's role in the amelioration of reading problems includes the detection of ways of improving visual efficiency and facilitating the acquisition of visually-related reading sub-skills, so that remedial teaching is more successful.[13] Careful clinical judgement is required to provide balance between vision therapy and any other remedial approaches. The time available for parents and children to engage in vision therapy is limited so that consideration of interdisciplinary integration of remedial approaches is required.[13] It is regrettable that Kiely, Crewther and Crewther[7] expended so much time and effort in their study without recognition of the experimental design problems that have characterized similar studies. Their finding that there is no statistically significant relationship between accommodative dysfunction and reading difficulty can be misconstrued. Readers of their report such as Dr Goldberg,[1] may not appreciate its limitations and, as a consequence, use their statistical outcomes to reach false conclusions about the role of optometric vision therapy in the treatment of children with learning related vision problems. The similar view of some ophthalmologists and pediatricians, as reported by the Committee on Children with Disabilities,[12] appears to have been based on the same type of misunderstanding.

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References

1. Goldberg HK. Letter to the editor. J Behav Optom 2002;13:75-6.
2. Press LJ. The interface between ophthalmology and optometric vision therapy. J Behav Optom 2002;13:37-41.
3. McMonnies CW, Ho A. Conjunctival hyperaemia in non-contact lens wearers. Acta Ophthalmologica 1991;69:799-801.
4. Morrison DC. Neurobehavioral and Perceptual Dysfunction in Learning Disabled Children. Lewington, New York: C.J. Hogrefe, Inc, 1985:1-9.
5. Lerner J. Learning Disabilities. Boston: Houghton Mifflen, 1981:323-49.
6. Bannatyne A. Research design and progress in remediating learning disabilities. J Learn Disab 1975;8:345-348.
7. Kiely PM, Crewther SG, Crewther DP. Is there an association between functional vision and learning to read? Clin Exp Optom 2001;84:346-53.
8. Kavale K. Meta-analysis of the relationship between visual perceptual skills and reading achievement. J Learn Dis 1982;15:42-51.
9. Simons HD, Gassler PA. Vision anomalies and reading skill: a meta-analysis of the literature. Am J Optom Physiol Opt 1988;65:893-904.
10. Kiely PM, Crewther SG, Crewther DP. Vision and learning to read. Letter to the editor. Clin Exp Optom 2002;85:260-62.
11. McMonnies CW. Vision problems and learning disability. Aust J Optom 1976;59:381-83.
12. Learning disabilities, dyslexia, and vision: a subject review. Committee on Children with Disabilities, American Academy of Pediatrics (AAP) and American Academy of Ophthalmology (AAO), American Association for Pediatric Ophthalmology and Strabismus (AAPOS). Pediatrics 1998 Nov;102(5): 1217-9.
13. American Academy of Optometry. American Optometric Association. Vision learning and dyslexia. A joint organizational policy statement. Optom Vis Sci 1997;74:868-70.
14. Lemp MA. Report of the National Eye Institute/industry workshop on clinical trials in dry eyes. CLAOJ 1995;21:221-32.
15. McMonnies CW. Key questions in a dry eye history. J Am Optom Assn 1986;57:512-17.

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