

## Sight-Reading Music: A Unique Window on the Mind

Copyright © 1998 Norman M. Weinberger  
and the Regents of the University of California. All Rights Reserved.

*Music research affords the potential to discover new capacities and processes of the human mind. However, music cognition and behavior are often viewed merely as an instance of other, better known subjects. An example is music sight-reading, often believed to obey the laws of language reading. However, recent studies reveal that the study of sight-reading in music provides a unique window on the mind.*

The human brain is perhaps the ultimate topic in all of scientific endeavor. This may seem like a preposterous overstatement; after all, the brain is just one of many interesting things. True, but reflect for a moment -- the brain is the gateway to all of these other things, to all knowledge of the world. It is only through our brains that we can perceive and learn about what is outside our brains. Thus, what we can know about anything depends upon what the human brain can do and how the brain does it all. Many people consider these two issues -- brain capability and brain function -- to be paramount questions.

Brain capability includes the competency to conceive, compose, read, perform, perceive and comprehend music. Therefore, to understand the brain means we have to understand musical competence and its neural substrates. But there are scores, maybe hundreds, perhaps thousands of brain abilities; consider the enormous variety and complexity of human behavior. Every single possible type of thought or behavior can't be understood ... there are too many. And of course this is true. But scientists don't attempt to examine every single instance of experience or of the rest of the physical world for that matter. Rather, they seek general principles and laws that explain what is known and predict what is not yet known. Specific instances of brain function, and of whatever else goes on in the universe, are individual cases of universal laws. Once the boiling point of water (at sea level) has been determined, and explained by physical laws, there is no need to check the temperature of the pot everytime water starts to boil on the stove. The same logic holds for the brain and behavior.

But why should understanding music, the brain and behavior be of particular interest or receive special attention? Music behavior could well be an instance of other forms of brain function, for which explanations and understanding are far advanced, perhaps completed. Let's accept this view, and ask how we can decide if it's true. An obvious way is to determine if the findings for a known related behavior also apply to music behavior. If they don't, then music behavior provides a new contribution to understanding the human mind and demands answers of its own.

Let's take the case of reading. This topic has been intensively studied for many years. An important line of inquiry uses precise measurements of eye-movements during reading to determine the mental strategies used to read. (The tracking of eye movements is a valid way of determining the moment-to-moment location of attention, because adequate reading requires that the central axis of the eye be directed to the text, i.e., reading is poor with peripheral vision.(1)) In reading, very rapid brief movements, called "saccades" are

followed by longer periods of fixation, during which the actual perception of the text occurs. This sequence occurs several times per second and is done essentially unconsciously. Thus, analysis of eye movements can determine if people attend to individual letters, words or phrases. Eye movements also can be divided into forward, along the progressive line of text, and regressive, back toward a part of the line already covered. By noting the location, duration, direction and pattern of saccades and fixations, it is possible to obtain an objective indicator of mental strategies in reading language. For example, readers avoid fixating blank areas between words. Also, poor readers make many more regressive eye movements than do better readers.(2) In this case, comprehension would seem to depend on textual review.

A related task in music is sight-reading, that is reading an unknown score while performing the music.(3) T. W. Goolsby has pointed out that music educators have adopted language reading as the basis for instruction and evaluation of sight-reading. He questions whether this is appropriate.(4) If sight-reading music is simply another instance of language reading, then the same pattern of eye movements should occur, but if the pattern is different, then sight-reading can't be explained simply by the principles that operate in language reading.

In a study of vocalizing (e.g., humming) during sight-reading, Goolsby observed major differences between reading music and reading language. First, he found the *opposite* pattern of eye movements to language reading: i.e., poor sight-readers made fewer regressive eye movements while better performers had many more such movements.(5) Additionally, he reported a perceptual span that included the vertical as well as horizontal dimension (as might be demanded by attention to the staves of music), overall more eye movements in better sight-readers and less attention to details of the musical score than for language reading.(6) Regarding the last point, Goolsby found more fixations to blank spots in the score (less attention) despite the fact that music demands exact reproduction of the details whereas language reading requires obtaining only the meaning, not the physical reproduction, of the text. It seems that the mental strategy in music is to look ahead to determine where the score is "going" (obtaining the "larger picture"), making inferences about many of the details of the score (given a knowledge of e.g., harmony in Western tonal music), thus obtaining a sufficient framework within which to look back to notes that are just ahead of the notes being performed -- and repeating this complex process again. All of this occurs as often as five to six times per second! Therefore, reading music apparently is not an instance of reading text, but a process unto itself. Consequently, music seems to provide a unique window into the mind.

On the other hand Rayner and Pollatsek report strong commonalities between sight-reading and reading language, and also typing. They have noted that sight-reading requires two conflicting processes. First, there is the visual encoding of the score; one would like this to be well ahead of performance so the score in all its nuances, can be understood before "translating" the information into motor acts. However, if the eyes get too far ahead, then an overload of information can result, interfering with good performance.(7) By careful control of the presentation of a novel score by computer, synchronizing it with performance, these authors have determined the actual perceptual

span of this "forward look". They note that reading aloud and typing also have similar-sized "looks", suggesting that the limiting factor in all three situations is the same, a limitation on the capacity of short term memory.

Thus, we have two apparently opposing conclusions about the uniqueness of sight-reading in music as an entry point into the mind. Rayner and Pollatsek emphasize commonalities between sight-reading and other perceptual-motor activities while Goolsby focuses on differences between reading music and language. Which is correct?

Probably both. The two views can be reconciled by realizing that the brain has general constraints; it can't do everything. So general limitations on short term memory, for example, force the same upper limitations on performance in sight-reading, reading language aloud and typing. In short, we can't transcend our brains. On the other hand, within the limitations of mental functioning, there is a great deal of flexibility, many ways to solve problems and achieve desired behaviors. Sight-reading makes demands that differ, perhaps fundamentally, from the other tasks. To be successful, mental processes and strategies must match the special demands. That the patterning of eye movements, which are a convenient "window to the mind", is unique to sight-reading forces us to enlarge the way we think about the visual encoding and understanding of symbols, and the resultant behavior. Thus, while having certain commonalities with other activities, sight-reading as a part of music seems to involve a unique combination of mental processes.

-- N. M. Weinberger

(1) Rayner, K. and Bertera, J. H. (1979). Reading without a fovea., *Science*, 206, 468-469.

(2) Rayner, K. and Pollatsek, A. (1989). *The Psychology of Reading*. Englewood Cliffs, N.J.: Prentice-Hall.

(3) The performance aspect of music sight-reading is used to assess how well the score was understood, as one can't simply give a standard test of comprehension as in text reading.

(4) Goolsby, T. W. (1994). Eye movement in music reading: effects of reading ability, notational complexity, and encounters. *Music Perception*, 12, 77-96.

(5) *Ibid.*

(6) Goolsby, T. W. (1994). Profiles of processing: eye movements during sightreading. *Music Perception*, 12, 97-123.

(7) Rayer, K. and Pollatsek, A. (1997). Eye movements, the eye-hand span, and the perceptual span during sight-reading of music. *Curr. Direct. Psychol. Sci.*, 6, 49-53.

~ ~ ~

<http://www.musica.uci.edu/mrn/V5I1W98.html#sightreading>