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"The Heard Brain"

Reading *Music, Language and the Brain*

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***Abstract*—*Music, Language and the Brain* is an attempt to explore the relationship between music and language from the perspective of cognitive neuroscience. It argues that these two domains share deep and critical connections and that comparative study provides a powerful way to explore the cognitive and neural mechanisms underlying these unique human abilities. This review article examines the viewpoints of the book and its implications of future research.**

***Keywords*—music, language, brain; processing mechanism**

I. INTRODUCTION

Language and music are closely related to human life. The characteristics of music and language exist in all human societies (Netttl, 2000). As the two most important products that human vocal organs can produce, language and music both involve complex and meaningful sound sequences. Therefore, it is natural to compare these two fields.

II. PREVIOUS STUDIES

Since Plato's time, the relationship between music and language has long drawn interest from a wide range of thinkers, including philosophers, musicologists, linguists, writers, composers and so on (Patel, 2008). As early as two thousand years ago, Plato believed that the power of certain musical modes to uplift the spirits stemmed from their resemblance to the sounds of noble speech (Neubauer, 1986).The famous Chinese musician Yang Yinliu once elaborated on the relationship between language and music in his book A Preliminary Study of Language Musicology and analyzed the musicality of Chinese language from the phonetic system (Yang, 1983). The American composer Leonard Bernstein made a series of lectures in Harvard in 1973 and began to analyze the grammar of Western tonal music in the framework of linguistics, which aroused people's interest in music and language syntactic comparison (Bernstein,1976). Getting inspired by these lectures, American composer and music theorist Fred Lerdahl and American linguist Ray Jackendoff proposed GTTM - a generative theory of tonal music, which constitutes a "formal description of the musical intuitions of a listener who is experienced in a musical idiom" (Lerdahl & Jackendoff,1983). Developing the earlier proposals by Lerdahl and Jackendoff, Jonah Katz and David Pesetsky, professors of linguistics at MIT, further proposed identity thesis for music and language, arguing that music, like language, contains a syntactic component in which headed structures are built by iterated, recursive, binary merge and a musical prosodic component which interacts with the syntactic component in the similar way between syntactic and prosodic structure in language (Katz & Pesetsky, 2009). These theories have been influential, spurring further work in the fields of music theory, music cognition and cognitive musicology.

III. A NEW PERSPECTIVE

However, from the perspective of modern cognitive science, the exploration of the relationship between music and language has only just begun. *Music, Language and the Brain* is such a good attempt which tries to open a new door for us to explore the deeper relationship between language and music from the perspective of neuroscience. The book was written by Aniruddh D. Patel who obtained his Ph.D. in biology from Harvard University and currently becomes a professor in the Department of Psychology at Tufts University. His research interests are mainly about what can be discovered about the brain through examining how the brain processes music and language and the similarities and differences of the two processing mechanisms.

As the first comprehensive study of the relationship between music and language from the perspective of cognitive neuroscience, *Music, Language and the Brain* challenges the widespread belief that music and language are processed independently and emphasizes the commonality of music and language on the basis of recognition of differences between language and music. Dr. Patel believes that the similarity of music and language is more prominent than diversity at many levels. Although music and language use different representations, for example, musical intervals do not exist in the language, grammatical representations of nouns and verbs in the language are not found in music, but the processing mechanisms and neurobiology of these representations are extracted and integrated. The learning infrastructure may be largely shared. Therefore, Dr. Patel proposes "Shared Syntactic Integration Resources Hypothesis" (SSIEH) which believes that language and music syntax have shared sorting mechanisms and these mechanisms are implemented in overlapping frontal lobe regions, manipulating domain-specific syntactic representations of the posterior brain

regions (Patel, 2008). The book provides an extensive and in-depth discussion of these mechanisms from Chapter 2 (chapter I is an introduction) to Chapter 7.

Specifically, the second chapter discusses the human ability to learn sound categories. In the study of the relationship between music and language, it has been found that by contrasting the sound system of language and music, these two fields are very different: Music uses pitch as the main basis (such as interval and chord) of the sound category while the main basis of sound category of language is timbre (such as vowels and consonants); the way music uses pitch is also different from speech, and the degree of speech organization is rarely seen in music. However, Dr. Patel argues that under these differences, there is a profound connection between cognition and neural processing since both fields are associated with a specific aspect of sound, such as pitch in music and timbre in speech, forming a perceptually discrete system. This perception discretization reflects the activities of the cognitive system, that is, to distinguish between differences in the range of sound changes and indications. Although music and speech are used to distinguish the sound features of sound categories from one another, the mechanisms that form and maintain learned sound categories may overlap to a great extent in both areas. This overlap provides new insights into human unique communication skills (Patel, 2008).

Chapters 3 and 4 discuss the ability of humans to extract statistical rules from rhythms and melody sequences. Both speech and music involve the systematic mode of sound in time, stress, and phrase. One major difference is that the periodicity of time is very extensive in music, but it does not exist in speech rhythms. After breaking the "periodical link" between speech and music and shifting the research focus from periodical to non-periodic characteristics of rhythm, Dr. Patel has revealed many interesting connections, such as the reflection of speech time patterns in music and the influence of speech rhythm pattern on non-verbal rhythm pattern combination preference. Therefore, it can be basically determined that some of the main processes for extracting rhythm structures from complex acoustic signals are the same in music and language (Patel, 2008). The empirical study of the melody of music and language shows that although there are major differences between the two areas of the melodic system, for example, the use of scales and intervals in music, with regular beats and center tones, there are many links between the two areas in terms of structure and processing. It has been found that the statistical characteristics of the pitch pattern in the composer's native language may be reflected in his composition of instrumental music. There are also neuropsychological studies showing that the way the brain processes spoken melody contours and music melody contours is coincident (Patel, 2008).

Chapter 5 examines the ability of humans to integrate input components (such as words and tones) into a syntactic structure. The study of aphasia has found that although music and linguistic syntax have different domain-specific syntactic representations, the neural resources used to activate and integrate these representations overlap during syntactic processing. The absence of these resources affects both music and language. From a neurolinguistic point of view, it reveals difficulties in activating stored syntactic representations in patients with aphasia; from the perspective of music cognition, these results indicate that the language circuit in left brain plays an important role in syntactic processing of music for non-musicians (Patel, 2008).

Chapter 6 examines the ability of humans to extract subtle emotional significance from sound signals. In connection with musical and linguistic meaning, Dr. Patel focuses on the connection between the acoustic parameters of speech and music and the neural connections of auditory affect processing. Studies have shown that the acoustic cues of speech emotions have cross-cultural consistency because even if the content is said to be emotionally neutral (such as weather forecasts or menus), or semantically incomprehensible, as in foreign languages, it is still possible for listeners to interpret the basic emotions expressed through acoustic cues, including happiness, sadness, anger and fear. Through the analysis of acoustic cues in the expression of emotions in music and spoken language, it is found that there is a large number of overlapping acoustic cues used to express basic emotions (Patel, 2008). However, the current research on emotional processing is inconsistent, and there is not enough evidence to show whether the brain processing areas of voice emotions and musical emotions are the same.

The last chapter of the book (Chapter 7) explores the extent to which human language and musical abilities are influenced by natural selection from the perspective of biological evolution. Based on 10 pieces of persuasive evidence, Dr. Patel tends to believe that natural selection plays a direct role in the evolution of human language, but by examining the research evidence that natural selection directly shapes human music ability, there is currently no way to prove that the brain has specifically prepared for musical cognition. Existing studies have suggested that the pitch processing of music does not meet the three criteria of domain specificity, congenitality and human particularity. However, the rhythm processing of music has not yet been tested. Dr. Patel believes that there is a wide-ranging aspect of music rhythm that deserves attention, namely rhythm processing based on beats. This real-time integration of voice and motion systems places special demands on the nervous system because the direct and tight coupling of the auditory input and movement output may be a necessary basis for beat synchronization (Patel, 2008). However, whether the learning ability of synchronized movement with music beats is unique to humans still needs further examination.

IV. IMPLICATIONS FOR FUTURE WORK

Reading Dr. Patel's *Music, Language and Brain* is a very rewarding experience because it provides a new perspective for us to understand how the brain expresses meaning through sound. By reviewing a large number of empirical studies, the deep neurobiological relationship between language and music is tapped. We have learned

that although there are great differences in the characterization of music and language, their deep processing mechanisms are closely related. These research results can inspire future work in various fields. For example, Dr. Patel argues that if the brain overlaps the mechanism by which sound waves are converted into the discrete categories of speech and music, we can be sure that training in one domain of sound can enhance the ability to obtain sound categories in another (Patel, 2008), which may imply a relationship between language learning ability and musical ability. In the book Dr. Patel mentioned a research conducted by Slevc and Miyake in which a language test and a music test on 50 Japanese adults living in the United States and learning English were carried out in order to determine whether musical ability could explain the difference in second language ability that other variables could not explain. After using layered regression to eliminate the effects of other variables, they found that musical ability did predict differences in second language skills (Slevc & Miyake, 2006) .

Secondly, intonation teaching in second language has always plagued many language teachers. To speak a language fluently, it is not enough to master its syllables, vocabulary and grammar. It is also necessary to grasp the time and accent pattern of the syllabic flow characteristics in the sentence. In other words, the inability to learn the rhythm and pitch pattern of the target language is the main reason for the "foreign tone". It might be a research direction of specific practical significance to train language learners from the two aspects of the musical pitch and rhythm of the target language to achieve the goal of improving the learners' target language sense.

Besides, the results of this book may also open a door to our understanding of Chinese Yinsong, a musical form of ancient Chinese poetry and literary reading, which had a great value and a far-reaching influence on traditional Chinese classic education. As a perfect form of combination between music and language, Yinsong used both musical and linguistic features in expressing emotions and deepening cognition. However, the existing research stays on the description of the phenomenon and lacks the deep exploration of its working mechanism (Xue, 2012). *Music, Language and the Brain* provides a possibility of the use of new concepts and technology to investigate the neural correlates of music and language, which may eventually solve the mysterious power of Yinsong.

V. CONCLUSION

The study of the relationship between language and music is particularly exciting because it combines science and studies of humanities, enabling people to have scientific arguments about all the wonderful guesses about music and language. Since the book was published in 2008 by Oxford University Press, it has won a lot of praise. For example, Carol L. Krumhansl, professor of psychology at Cornell University remarked that *Music, Language, and the Brain* would shape and inform research on the relationship between music and language for decades to come. D. R. Ladd, professor of linguistics of University of Edinburgh believed that this book would be required reading for specialists, and interesting and informative reading for everyone[1]. As the winner of the 2008 ASCAP Deems Taylor Award, *Music, Language, and the Brain* was translated into Chinese in 2012 and republished in 2014. As the reviser and one of the major translators, professor Yang remarked that psycholinguistics and music psychology in China were less advanced, compared to other branches of psychology and the introduction of this book would inform the scholars in different fields with the latest research findings and drew their attention to the interface of these research fields (Patel, 2012).

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