

The Acoustics of Speech in Individuals who Stutter: Literature  
Review

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## The Acoustics of Speech in Individuals who Stutter

### *Introduction*

Research concerning acoustics in children who stutter, who have recovered from stuttering and adult stutterers shows that there is a lack of coherency in the data collected and reforms need to be made to the methods involved. The research that has been conducted on stuttering pertains mostly to the condition in children; stuttering is most prevalent in younger children and in most cases will be corrected by the later years of youth. Researchers working within the field are confronted by many problematic factors when both conducting their research and specifically in analysing data. Diverse methods of data compilation and independent methods of interpretation mean that what one scientist concludes from an experiment may not support established theories and existing information on the subject.

It can be assumed that analysis of acoustics in stuttering needs to be done with a specific framework that all researchers can work from. Issues like the diagnosis of stuttering complexes from mild, moderate and severe; the focus on frequency changes; and subtyping have all been encountered and brought up for review by researchers who wish to have a more fully rounded database from which to study stuttering in all its forms. A review of literature on the subject exposes many difficulties within the field of research and offers suggestions on how these might be addressed and overcome. Once a basic premise for observation,

study and analysis is reached, the database will be much more comprehensive and useful to future research.

#### *Literature Review*

Acoustic analysis is the foundation to stuttering research conducted by many different scientists and scholars; the ways in which this research is conducted vary, however, and therefore can produce subsequently varied results and different ways of looking at stuttering itself. Some researchers are of the opinion that stuttering is heavily influenced by the actual perception of listeners, and that though analysis of reaction and perception of acoustics in stutterers it is possible to more fully comprehend those characteristics of speech that are a part of the disorder (Amir, Yairi). Through analysis of speech patterns in preschool aged children, the researchers concluded that interval duration in speech patterns must exceed 70 ms to be considered normal speech; under 50 ms interval duration was therefore attributed to stutterers.

Some researchers have taken acoustic analysis to a new level with the use of the computer as a more failsafe analytical tool; due to a lack of specific acoustic parameters by which to classify stuttering the computer offers a more solid foundation for diagnosis and treatment (Brosch, Hage, Johannsen). Research conducted by these authors was inconclusive because of a lack of cohesive data on the subject, however it is their belief that with further study one might better understand the correlations between specific acoustics and the different stages of

stuttering. The primary factor thought to be attributed to stuttering in different stages is age.

Chang, Ohde and Conture believe that it is a disorganization of specific factors of speech, in particular the transition rate of speech formation, that can be cited as a precursor to stuttering. This research is key to the development of stuttering studies because currently there are very little data or theoretical models to explain the conditions that lead to stuttering in children. Through acoustic analysis not only of children and adults who currently stutter, but the acoustic analysis of children who will later develop a stutter, these researchers believe that more will be understood about the progression of the disorder and subsequently the treatment methods themselves.

Given the generalities of much stuttering data, it has been concluded that subtyping of the disorder would help greatly with further research and the future specialization of treatments and diagnoses (Yairi). In this case, the acoustic analysis carried out by researchers would be made very specific and varied: attention would be paid to transition rates, vowel duration, particularities of speech disfluency and other inconsistencies attributed to stuttering. Yairi's research has yet to lead to subtypes of the disorder, however the belief remains that through more acoustic analysis, enough data will be gathered to start separating the disorder into more than one general field.

Frequency changes and second formant transitions in preschool children who stutter persistently and who have recovered from the condition show general differences in speech patterns between the two groups. Most poignant was the fact that the research showed frequency changes in persistent stutters were discreet while the recovery group showed marked frequency changes (Subramanian, Yairi, Amir). Research such as this helps to support Yairi's theory that subtyping may be useful in the field.

Along these lines, Armson and Kalinowski pointed out the difficulties in performing acoustic analysis on stutters when the condition itself may be changing the data. These researchers feel that to properly assess acoustic data they must learn how to separate those factors out which cause stuttering, and which are inherent in individuals only after one has begun to stutter. The acoustics of one individual in a pre-stuttering state might show related frequencies and vowel duration, as well as the same speech rate and consonant-vowel repetitions to that of a stutters; the researchers maintain, however, that the cognitive functions of one who stutters might be significantly different than that of an individual who does not stutter but will later develop the disorder. Cognitive and acoustic factors of stuttering are currently inextricable from those of the pre-stutterer, and until these can be separated the data gathered on the subject will remain generalized and of less value than it might be. As well as this, information on acoustics must be

analyzed both during the stutter and during normal speech in the same individual.

Paden, Abrose and Yairi studied the phonological acoustics of stutterers and non-stutterers to ascertain whether there were any significant differences between the two groups. Through the observation of children over a two-year span, attention was paid to not only current differences in the phonological skills of the children but the changes in those skill levels over time. They found that the phonological skill level of children who had recovered from stuttering were markedly higher than that of children who currently stutter; over the course of two years, however, the skill levels were developed and no significant difference could be shown.

Flipsen Jr., Hammer and Yost point out that perhaps the major flaw in the field is the fact that Clinicians are responsible for identifying stuttering cases and labelling them either mild, moderate or severe. This means that Clinicians must rely on their own individual acoustic analysis to interpret the severity of stuttering case by case, and in doing so are likely to be inconsistent. Personal analysis of the acoustics of several different individuals who stutter means that although analysis is based on regimented disfluency factors, such as vowel duration and frequency, relying solely on acoustic interpretation though listening cannot be scientifically sound. The researchers propose that a better method must be contrived in a study that supports Brosch, Hage and Johanssen's computer analysis theory.

In keeping with the idea that research on stuttering must be more specialized, Louis, Myers, Faragasso, Townsend and Gallagher have studied a particular disorder that is often attributed to stutterers but which they insist is a different disorder. Cluttering is an irregularity that has to do with the rate of speech: people with this condition will either speak more rapidly than normal or they will have inconsistencies in the rate of speech. While many researchers will have cluttering placed in the same field as stuttering, Louis (et al) believes that it is generalizations like this that cripple the scientific community. Acoustic analysis of cluttered speakers shows clearly that the condition is not the same as stuttering: while stuttering has a more clustered effect on the phonemes of speech, cluttering is less specific to certain vowel and consonant groups.

Gohinho, Ingham, Davidow and Cotton have discovered that in treatment of stuttering, the reduction of short-deviation phonetic intervals has a direct affect on the condition. Acoustic analysis of normal stuttering and manipulated speech in normal stutterers suggested that phonetic interval distribution in the two speech groups were generally different; this theory was inconclusive. In terms of treatment, however, it has been useful and is thought to offer new possibilities in treatment procedures.

Ingham, Fox, Ingham, Xiong, Zamarripa, Hardies and Lancaster conducted their own research based on gender differences between stutterers. Data were collected in terms both of acoustics and

of cerebral blood flow in adults. While females are more likely to recover from stuttering in childhood and males are generally more susceptible to the condition, this research found that the stages of recovery were not significantly different between the gender groups. The researchers concluded that chronic stuttering was related to abnormal speech-motor and auditory region interactions.

Healey and Ramig conducted research into stuttering that was specific to treatment, specifically treatment length and its effect on differing severities of the condition. Acoustic analysis of patients undergoing treatment showed that the severity of each case made no significant difference to recovery and the transition from one level to another; similarly treatment time made no difference in the progression and recovery of stutterers.

Max and Caruso also explored treatment options, finding that fluency adaptation through the process of repeating specific readings was improved over other methods of treatment. With specific phonological aspects in the readings, designed to contain certain phrases and vowel-consonant groups that give stutterers trouble normally, these were given to treatment patients to repeat until any changes were observed in speech patterns. Repetition treatments have traditionally very popular and due to their superiority over many other methods these treatments continue to dominate in the field.

Specific study of the different aspects of language and acoustics means that a scenario for stuttering can be pieced together slowly and formed of many different speech parts as well as cerebral and other physical data (Natke, Grosser, Sandrieser, Kalveram). Research into the effect of stressed syllables within speech and stuttering was conducted with reference to the length of such syllables. Natke and his colleagues hypothesized that stressed syllables were responsible for stuttering in many individuals, and studies proved that these were indeed catalysts for stuttering in most cases. Whether or not duration of stressed syllables has anything to do with disfluency is not yet apparent.

Currently, Yaruss believes, no correlation can be drawn between utterance rates and response time latency. His own research explored these and consequently still was not supportive of the theory that conversational speaking rates were actually related to response time latency. He does believe that if more research were conducted into this area, a correlation would indeed be found; inadequate methods of acoustic analysis are cited as the reason why hypotheses such as these remain unproven.

In Yairi's response to the criticisms of Wingate on his theories of diversity in the field of acoustic study, he asserts that there are many different ways to study stuttering and that these varying methods should be valued. Wingate proposes, like many scholars, that there should only be one method of study so that subsequent data compilations are relevant to one another and

more easily formed into future subdivisions of the disorder. While Yairi does not dispute the value of specialization within the field for the sake of greater knowledge and better treatment plans, he does maintain that a fundamental diversity among researchers is a positive attribute. In terms of acoustic analysis, this means that the lack of cohesion between existing research would persist.

#### *Evaluation of Published Research and Conclusions*

Overwhelmingly, researchers in the specific linguistic field that study stuttering and its related conditions are asking for continuity in research methods and data organization. While independent researchers and study groups might be able to find their own way of cultivating data, studying acoustics of stutterers, non-stutterers and recovering stutterers and interpreting this data, it is essentially of no use to the rest of the field unless aspects of the study can be repeated.

Researchers like Brosche, Hage and Johanssen are particularly forward thinking in their approach to acoustic analysis, because unlike so many of their colleagues they are not continuing to rely on what they believe to be inferior techniques. The use of computer analysis in terms of stuttering acoustics not only means that a discrepancy between professionals can be ruled out in the future but that further information can be gathered concerning speech patterns that are undistinguishable to the unaided ear.

Yairi is also correct when he says that there is more than one way to study stuttering. If all researchers relied on

exactly the same techniques then no breakthroughs could be expected in the field; despite this fact most acoustic analysts who wish to better understand stuttering simply want a basic framework upon which to base their own studies and interpret the results of others. If a certain degree of flexibility could be maintained in acoustic analysis while certain fundamental factors were incorporated, researchers would be in a better position to interpret and present their own results in relation to the work of colleagues.

Factors that might feature in each research project might include vowel duration, second formant transition, conversational speed and other specific disfluency forms. By using these factors in all research related to stuttering, whether the study is based on such factors or not, will mean that although two research projects might be based on completely different theories the results can still be comparatively put together. If one research project focuses on brain activity and blood flow during stuttered speech, and another focuses on frequency, results may still have relevance to one another because of the use of basic acoustic analysis.

Coherency is needed in this field of research so that results and future treatments are made clearer. Implementing basic acoustic analyses in every research project will help to form a stuttering database that can be referenced by every researcher.

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