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Theories, Facts, Assessments, and Treatments of Stuttering

― How are theories and facts of stuttering consistent with our practice? ―

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Abstract: Most of the books on stuttering define that stuttering is an interruption in the normal rhythm of speech manifested by symptoms of involuntary (1) repetition of words, part-words, or sounds, (2) prolongation of sounds, and (3) blocking of words, all of which are usually accompanied by tense movements of the face, jaw, and occasionally an extremity. However, this tells us only a part of the complex stuttering phenomena. This is true that people who stutter suffer from these overt phenomena; however it is also important to investigate where these phenomena come from. Currently, researchers on stuttering suggest that stuttering contains not only motor problems but also many other covert problems which may cause or influence overt aspects of stuttering symptoms. Nowadays, the multidimensional model of stuttering is one of the most popular models in the areas of stuttering research, assessment, and treatment. This model hypothesizes that the overt stuttering problem, which is a breakdown in motor processes, is influenced by a variety of factors. Researchers conceptualized the problems of stuttering in five factors, which were cognitive, affective, linguistic, motor, and social components. On this paper, the author introduced several major theories of stuttering and the facts we know about stuttering, and then discussed how to mediate between the facts or theories and clinical work for people who stutter.

Key words: stuttering, multidimensional model, CALMS, speech therapy

Ⅰ. Introduction

Stuttering is an interruption in the normal rhythm of speech manifested by symptoms of involuntary (1) repetition of words, part-words, or sounds, (2) prolongation of sounds, and (3) blocking of words, all of which are usually accompanied by tense movements of the face, jaw, and occasionally an extremity (Manning, 2000). However, this tells us only a part of the complex stuttering phenomena. This is true that people who stutter suffer from these overt phenomena; however it is also important to investigate where these overt phenomena come from and to understand how people who stutter are supposed to deal with covert phenomena, such as affective, attitudinal, and social aspects of stuttering.

Scientific studies on stuttering started in late 1920s by several researchers at the University of Iowa (Orton & Travis, 1929; Travis, 1931). Their primary interest of stuttering was the relationship between handedness and stuttering because the researchers in that era believed that people who stutter were either left-handed or ambidextrous. They hypothesized that people who were left-handed or ambidextrous got confused in their brains when they spoke because the

muscles of the speech mechanism received nerve impulses from both the left and right hemispheres of the brain, whereas one hemisphere needed to be dominant over the other in order for speech movements to be properly synchronized. Later, their hypothesis was denied because there were also many people with stuttering who were right-handed and those without stuttering who were left-handed or ambidextrous.

Nowadays, due to the invention and progress of medical technology, many researchers again were shifted their interests from physiological aspects of stuttering to brain anatomical and functional difference between people who stutter and those who do not stutter (Kawai, in print). Of course, it will not be enough to understand only overt aspects of stuttering.

Currently, researchers suggest that stuttering is not only a motor problem but also it contains many other covert problems which may cause or influence overt aspects of stuttering symptoms. The multidimensional model of stuttering is one of the most popular models in the areas of stuttering research, assessment, and treatment. This model hypothesizes that the overt stuttering problem, which is a breakdown in motor processes, is influenced by a variety of factors. For example, Healey, Scott Trautman, and Susca (2004) conceptualized the problems of stuttering in five factors, which were cognitive, affective, linguistic, motor, and social components.

On this paper, the author introduced several major theories of stuttering, the facts we know about stuttering based on physiological and brain studies on stuttering, and how we can mediate between the facts or theories and clinical work for children who stutter.

Ⅱ. Theories and Facts in Stuttering

1. Biological Background

1) Physiological Perspectives

The belief that stuttering results from an abnormality in the tongue's structure, function, or both, appears to have been the most widely held view during 1500 A.D. (Bloodstein, 1995). Since one or more anatomical structures were thought to be implicated, it was common to recommend various forms of surgery for those who stutter. In 1841, a German surgeon performed more than 250 operations on the tongues of people who stutter in France and Germany (Manning, 2000). He claimed that his technique was successful, but the success lasted for only a short period of time. There is also a long history of placing objects in the mouth or next to a variety of locations in the vocal tract in order to elicit fluency. With few exceptions, however, these devices provided, at best, only temporary fluency.

During 1960s and 1970s, researchers considered a root of the stuttering problem was inefficiency or over adduction of the vocal folds. They observed and compared the patterns of vocal fold movements during stuttered and nonstuttered speech (see Kawai (in print) for the detailed review of physiological aspects of stuttering).

2)Theories of Cerebral Dominance

In late 1920s, researchers suggested that individuals who stutter are more likely to be left-handed or ambidextrous than non-stutterers and that the onset of stuttering had occurred in conjunction with attempts to change their handedness. Orton and Travis (1929) and Travis (1931) hypothesized a theory of stuttering that would become known as "the Cerebral Dominance Theory". They suggested that because the muscles of the speech mechanism receive nerve impulses from both the left and right hemispheres of the brain, one hemisphere needed to be dominant over the other in order for speech movements to be properly synchronized. Orton and Travis (1929) and Travis (1931) also claimed that the nervous system of people who stutter had not matured sufficiently to achieve hemispheric dominance over speech movements. This

immaturity was considered to be resulted from hereditary influences, disease, injury, or even emotional arousal and fatigue.

Initially, research on this theory focused on investigating the handedness of individuals who stutter, and the results were encouraging their assumptions. However, in later studies, there was little consistent support for the idea that people who stutter as a group differed from people who do not stutter on measures of handedness or sidedness (Orton & Travis, 1929; Travis, 1931).

Around 1960s, new interest in the Cerebral Dominance Theory emerged with the development of procedures that could specifically examine hemispheric dominance for language functions (Jones, 1966; Wada & Rasmussen, 1960; Zimmermann & Knott, 1974). However, some studies failed to find difference of cortical dominance for speech between people who stutter and those who do not (Guitar, 2006).

3) Evidence from Neuroimaging Techniques

Neuroimaging is a general term that refers to radiological and physiologic techniques that can provide a visual representation of intact, functioning neurological systems. Neuroimaging techniques can be categorized as either structural or functional. Structural neuroimaging studies identify anatomical structures of the brain and include Computerized Tomography (CT) and Magnetic Resonance Imaging (MRI) techniques. With structural imaging techniques, an indication of hemispheric localization of language must be deduced by comparing site of lesion with behavioral characteristics.

Functional brain imaging techniques can generally be divided into two categories. The first are radiographic techniques that investigate the physiological and biochemical properties of the brain including Functional Magnetic Resonance Imagining (fMRI), Positron Emission Tomography (PET), etc. Radiographic functional imaging techniques have been used in the investigation of brain activation patterns during speech and language tasks with a wide range of results. The second category of functional imaging are techniques that measure the brain's electrical activity including Electroencephalography (EEG). EEG is a graphic representation of the potential difference between two separated points on the scalp surface that represent brain transmitted electrical potentials, or brain waves. Nowadays MRI and fMRI are most popular technologies to reveal anatomical and functional difference of brains between people who stutter and those do not stutter.

Recent studies claimed inconsistent results on neuroimaging data regarding hemispheric specialization difference for speech and language processing in adults who stutter appear (Braun, Varga, Stager, Schulz, Selbie, Maisog, Carson, & Ludlow, 1997; Foundas, Bollich, Corey, Hurley, & Heilman, 2001; Foundas, Bollich, Feldman, Corey, Hurley, Lemen, & Heilman, 2004; Fox, Ingham, Ingham, Hirsch, Downs, Martin, Jerabek, Glass, & Lancaster, 1996; Fox, Ingham, Ingham, Zamarripa, Xiong, & Lancaster, 2000; Ingham, 2003). Some found anatomical difference in adults who stutter (Foundas, et al., 2001, 2004). They found abnormal gyri in the perisylvian frontotemporal regions and bilateral increases and atypical right-left asymmetry in the planum temporale. Others found functional difference in adults who stutter (Braun, et al., 1997, Fox, et al., 1996, 2000; Ingham, 2003). Chang, Erickson, Ambrose, Hasegawa-Johnson, and Ludlow (2008) summarized brain functional difference between adults who stutter and those who do not stutter: (1) reduced or abnormal activity was found in the auditory associated areas; (2) increased activity was found in the right frontal and left cerebellar regions; (3) abnormal temporal relationship between premotor and primary motor regions was found in the left hemisphere; (4) and increased activity was found in the left putaman, ventral thalamus, and inferior anterior cingulate. Further studies, specifically focused on early childhood, are necessary to identify structural or functional difference between individuals who stutter and those who do not stutter.

4) Temporal-Processing Abilities

Another area, where the results of many investigators are consistent, indicates that people who stutter are unable to process information about the precise temporal features necessary to monitor and produce speech (Kent, 1984; Wynne & Boehmler, 1982). The theme of these investigations is that people who stutter experience a subtle breakdown in speech or speech-related functioning. This breakdown, particularly when the speaker is experiencing internally or externally generated stress, may result in a reduced ability to achieve fluency (Fraisse, 1963). There is some indication that people who stutter perform less well than those who do not stutter controlling on tasks that require the discrimination of subtle temporal differences in signals (Kent, 1984; Wynne & Boehmler, 1982). This suggests that people who stutter may be demonstrating a lack of central nervous function that allows for the control of both incoming and outgoing signals. Although researchers found intriguing differences in speech related performances of people who stutter, the perplexing result continues to be that many of these participants do not show any difference in performance (Barasch, Guitar, McCauley, & Absher, 2000). Such differences may provide fertile ground in which stuttering may grow.

5) Genetic Influences

It has often been noted that stuttering tends to run in families, which suggests a genetic link for the disorder. Investigators who have considered the occurrence of stuttering in identical twins and fraternal twins have found stuttering to occur more often for both children in monozygotic pairs than in dizygotic twins (Andrews, Morris-Yates, Howie, & Martin, 1991; Luchsinger, 1944). However, some researchers found that even identical twin pairs did not result in stuttering in both members of the twin pairs (Howie, 1981; LeDoux, 2002). The occurrence of stuttering may be explained by a combination of genetic and environmental factors.

The ratio of stuttering in males and females may also interact with genetic loading for factors of fluency as well as recovery. The gender difference suggests that males are more susceptible to stuttering, females are more resistant to it, or both (Yairi and Ambrose, 1999). It may be true that females stutter only with a higher degree of genetic loading and also be more likely to pass it on to their offspring (Guitar, 2006). Similar findings have been noted in the studies that investigated familial history of stuttering (Ambrose, Yairi, & Cox, 1993; Andrews & Harris, 1964; Kidd, 1977, 1984).

6) Auditory Feedback

The nature of auditory feedback in people who stutter is another feature that has been the subject of research (Van Riper, 1982). For speakers who stutter, the distorted feedback creates the misconception that an error has occurred in the flow of speech. Stuttering occurs when the speaker attempts to correct an error that has, in fact, not occurred. It was generally agreed that people who do not stutter speak under DAF in much the same way people do when they stutter (Bloodstein, 1995). The effect of DAF on normal speakers is to produce repetitions and prolongations of sounds, slowing of speech, pitch increases, and greater vocal intensity. In order to be at the effect of DAF, people have to speak slowly, disregard the signal, and focus attention to undistorted tactile and proprioceptive feedback that is available to form his articulators.

More recent consideration of this view has failed to support the idea of an error in the feedback loop of people who stutter. Hartsuiker and Kolk (2001) asked their participants who stutter and those in the control group to detect self-produced phonemic errors under normal and masked auditory feedback conditions. The results failed to indicate that the experimental participants performed less well than nonstuttering speakers in either the accuracy or speed of their error detection.

2. Developmental, Environmental, and Learning Factors

1) Psychological Perspectives

This view came from physicians and speech clinicians who held a psychoanalytic view of the disorder in 1920-40s (Guitar, 2006). They viewed stuttering was an emotional or psychological disorder. Bluemel (1932) and Froeschels (1943) found that parents of young children who stutter set lower goals for their children than those of normally speaking children. Other studies found inconsistent results. For example, Johnson (1942) reported that parents of children who stutter were stricter than those of normal children. A recent review of studies that have investigated the influence of both home environment and parent-child interaction failed to support the view that parents of children who stutter have abnormal personalities or emotional or adjustment problems (Yairi & Ambrose, 1992a, b; Bloodstein, 1995; Guitar, 2006).

2) Stuttering as Learned Behavior

Other researchers viewed stuttering as learned behavior (Bloodstein, 1972; Johnson, 1959). This view of stuttering onset has been termed the Anticipatory-Struggle Model (Bloodstein, 1972). The essence of this model is that stuttering is learned behavior, which a person who stutters causes interference with the way he speaks because he believes that speech is difficult or will result in a failure. This was one of the most popular view of stuttering onset and development. One important implication of this view was to place problems within the area of educators rather than medical professionals.

The Semantic Theory of stuttering (Johnson, 1959) was one of the most popular theories that influenced in the area of stuttering research and implementation for long time. A key aspect of a general semantic approach to events and behavior is our interpretation of the events and our choice of labels for these occurrences. This theory held that stuttering evolves from normal fluency breaks that are overreacted to and mislabeled by the parents or other significant people in the child's environment. It also assumed that many children, including those who eventually stutter, experience a period of effortless fluency breaks. Furthermore, when children are penalized for producing these normal disfluencies, the result is both greater anticipation and increased struggle behavior. Stuttering, therefore, is created by listeners and then normal breaks in fluency have been shaped into stuttering (Johnson).

Recent studies show the results that do not support this theory. For example, Yairi, Ambrose, Paden, and Throneburg (1996) found different features of young children who had persistent stuttering and those who recovered from stuttering. They suggested that there are significant difference between those who recovered from and persisted in stuttering in terms of acoustic features, phonological skills, language development, and nonverbal skills. These results show that the signs of children who stutter were originally different from those who do not stutter or recovered regardless of how their parents interact with them.

3) Multifactorial Models

Most recent attempts to conceptualize stuttering as a multidimensional nature, which describe the many intrinsic and extrinsic factors that influence one's ability to produce fluent speech, have been increasing. Here, two main models are briefly introduced: the Demands and Capacities model (Starkweather, 1987; Starkweather, Gottwald, & Halfond, 1990) and the CALMS model (Healey, et al., 2004).

In the Demands and Capacities model (Starkweather, 1987; Starkweather, Gottwald, & Halfond, 1990), stuttering is viewed as reflecting an imbalance between the child's current capacities or abilities for producing fluent speech and the demands placed on the child. Demands may take the form of environmental demands (e.g., fast speaking rates used by parents) or self-imposed demands (e.g., excitements and anxieties). Capacities are viewed as inherited tendencies,

strengths, weaknesses, and perceptions, which may influence a child's ability to speak fluently. The CALMS model (Healey, et al., 2004) borrowed elements from existing multidimensional models of stuttering: Stuttering is a dynamic disorder and changes over time. Multiple factors (cognition, emotions, motor speech processes, social, and language) interact in a complex way to maintain stuttering. Children's capacity for fluency is influenced by their capacities or performance in a variety of demanding speech situations. A multidimensional model accounts for the heterogeneity of stuttering.

Ⅲ. Assessment and Diagnosis

1. Early Childhood Assessment and Diagnosis

Stuttering research on early childhood is one of the key areas that investigators have been conducted extensive amount of research in order to discover the cause of stuttering by comparing children who stutter and those who do not stutter.

Yairi and his associates have conducted many studies in this area since 1980s. The quality of their research was outstandingly high because they made an effort to increase validity and reliability in their research methods. They pointed out concerns about early studies in early childhood in stuttering. Yairi claimed that most of the studies relied on retrospective research methods such as interviews from parents, adults who stutter, and/or other professionals who do not know much about stuttering.

Yairi and Lewis (1984) analyzed spontaneous speech samples of young children who stutter and those who do not stutter. The results indicated that children who stutter demonstrated three times more disfluent speech than children who do not stutter. They also found the different disfluent patterns between these populations. According to Yairi and Lewis, the most frequent disfluencies in the speech of children who stutter, in ranked order, were part-word repetitions, disrhythmic phonation, and single-syllable word repetition, whereas the most frequent disfluencies of children who do not stutter were, in ranked order, interjection, part-word repetition, and revision-incomplete phase. Yairi and Ambrose (1992a, b) found the difference of age at onset between males and females. Their data showed that there were 5-month difference in mean age at onset between males and females. They also suggested that children who had severe stuttering also tended to have sudden onsets of stuttering.

Yairi, et al. (1996) introduced several factors which might distinguish between persistence and recovery groups of stuttering. They found that children in persistent group began stuttering five to eight months (M = 38.47) later than those who recovered (M = 30.20 (late recovered), 33.60 (early recovered)). They also found that more females recovered from stuttering than males. They said that a child who had stuttered for more than 12 months had an increasing chance of continuing stuttering although some spontaneous recovery continued to occur.

Yairi and Ambrose (1999) conducted longitudinal research on young children who stutter. They found that about 74% of children recovered from stuttering without any treatment and 26% of children persisted in stuttering. Yairi and Ambrose also found that duration of stuttering tended to run from 6 to 35 months for most of children who recover; however, they revealed that children in the persistent group stuttered from 49 to 131 months.

These results are beneficial to use as predictive factors of persistent or recovering stuttering when speech-language pathologists give parents advices on stuttering onset and development.

2. Using the CALMS Model for Stuttering Assessment

The CALMS model (Healey, et al., 2004) is not only a conceptual model to understand overt and covert problems of stuttering but also can be used as an assessment tool to evaluate multiple

aspects of problems and concerns relative to stuttering. Researchers have developed a preliminary rating scale to document a child's performance in cognitive, affective, linguistic, motor, and social areas (Brutten, 1986; Brutten & Dunham, 1989; Healey, et al., 2004; Nagasawa & Kawai, 1998). Ratings are based on a 7 point scale, where 1 = normal and 7 = severely abnormal. The rating scale accounts for both subjective and objective measures of performance. Ratings are based on levels of performance based on how children who stutter compare to how normal speakers would perform in each area. Each rating has its own category including two levels within the normal range, two levels that are considered borderline, and three levels of abnormal performance. Items selected for use under each CALMS component are based on typical information obtained in an evaluation of stuttering. The number of items varies across components and is related to how much information one could obtain in each area. A mean score is obtained for each component. Each average score is used to develop a graphic CALMS profile of performance.

Ⅳ. Treatment

1. Stuttering Modification Therapy

As mentioned above, the learning theory (e.g., the Anticipatory-Struggle Model by Bloodstein, 1972) has contributed to developing stuttering intervention methods (Van Riper, 1982). Stuttering modification therapy is one of the implementations based on learning theory and a psychological view of stuttering (Guitar, 2006). With regard to the structure of therapy, in stuttering modification therapy, a person who stutters and a clinician typically interact in a loosely structured manner. With adults and older children, the structure of therapy is characterized by a teaching/counseling interaction. With younger children, the context of treatment is often in play.

In terms of the second dimension of the therapy process, stuttering modification clinicians traditionally have not put much emphasis on collecting and reporting of objective data, for example, the frequency of stuttering before and after therapy. It is not that they are not interested in a client's progress; rather, they consider both their and the client's global descriptions and impressions of progress as more valid than rates of stuttering made in the treatment environment.

2. Fluency Shaping Therapy

In contrast, fluency shaping therapy is usually performed in a highly structured manner (Bloodstein, 1995). With their roots in operant conditioning and programmed instruction, fluency shaping clinicians put a great deal of emphasis on behavioral objectives and sequencing antecedent events, responses, and consequent events in a series of steps. Specific instructions and materials are often prescribed. Specific responses from the client are targeted, and specific reactions to these responses are required from the clinician (Guitar, 2006). As might be anticipated from their theoretical orientation, fluency shaping clinicians put much emphasis on collecting and reporting of objective and reliable data. They regard such information as extremely important in documenting their client's progress.

3. Applying Multidimensional Models into Therapy

The application of multidimensional models in stuttering therapy is more meaningful than just combining stuttering modification therapy and fluency shaping therapy because the CALMS model (Healey, et al., 2004) approaches multiple aspects of stuttering behaviors, which are cognitive, affective, linguistic, motor, and social aspects. In the cognitive part, clinicians provide basic information on stuttering. In this way, individuals who stutter become knowledgeable about stuttering, and better understanding on stuttering might also influence the affective part. They also discuss with individuals who stutter how to think and understand stuttering in better and more positive ways (Evans, Healey, Kawai, & Rowland, 2008; Healey, Gabel, Daniels, & Kawai,

2007). Next, in the affective part, clinicians and clients work together to reduce negative feelings and attitudes toward stuttering. Clients also learn how general listeners perceive the moments of stuttering based on periodical studies and reviews (e.g., Kawai, Healey, & Carrell, 2007). In the linguistic part, clients learn to control and shift linguistic demands to improve fluency. Then in the motor part, clients focus on speech skills that enhance fluency and modified stuttering. Finally, in the social part, mostly generalization techniques (Guitar, 2006) are used by applying the skills that are introduced previously in therapy rooms to realistic speaking situations, and transfer and maintenance the best conditions for a long period of time.

Ⅴ. Summary

In stuttering research, there are a lot of theories, facts, and assumptions that support the cause and/or development of stuttering; however, at the same time, there are a lot of facts and assumptions that are found inconsistent results. At this moment, there are quite limited number of theories, facts, and assumptions that explain cause or development of stuttering, but it does not mean that there is no way to help people who stutter.

Most importantly, even though the clear-cut cause of stuttering has not been found, there are quite strong evidence that tells speech clinicians who might recover from stuttering without any treatment or who might persist in stuttering. It is also important to watch not only overt behaviors of stuttering but also root or covert aspects of stuttering. The roots of stuttering such as emotional, cognitive, social aspects should be closely observed in order to better understand people who stutter.

In terms of the current status of stuttering intervention methodologies, most of them are based on the learning theory of stuttering. There are extensive amount of research that investigated how therapy changed physiological aspects of stuttering, but there are limited number of studies that showed how therapy changed psychological aspects of people who stutter, and the relationship between the efficacy of therapy and the alternation of brain function. It would be necessary to conduct evidence-based studies to prove the efficacy of intervention by investigating brain function as well as multiple aspects of stuttering, such as cognitive, affective, linguistic, motor, and social (Healey, et al., 2004).

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