1.Magnitude Estimation of disfluency by stutterers and nonstutterers.

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2.Summary

Everyone produces disfluencies when they speak spontaneously. However, whereas most disfluencies pass unnoticed, the repetitions, blocks and prolongations produced by stutterers can have a severely disruptive effect on communication. The causes of stuttering have proven hard to pin down - researchers differ widely in their views on the cognitive mechanisms that underlie it. The present chapter presents initial research which supports a view (Vasic and Wijnen, this volume) that places the emphasis firmly on the self-monitoring system, suggesting that stuttering may be a consequence of over-sensitivity to the types of minor speech error that we all make.

Our study also allows us to ask whether the speech of people who stutter is perceived as qualitatively different from that of nonstutterers, when it is fluent and when it contains similar types of minor disfluencies. Our results suggest that for closely matched, naturally occurring segments of speech, listeners rate the speech of stutterers as more disfluent than that of nonstutterers.

3.Introduction

Research into stuttering often seems to fall at the first hurdle: that of defining what constitutes a stutter, in contrast to the disfluent speech that everyone produces. As of yet there is no consensus on a formal definition: researchers such as Perkins (1995) emphasise the speaker's feelings of loss of control; others, such as Postma and Kolk (1993), prefer definitions in terms of the frequencies of particular types of disfluency. However, a consensus is slowly emerging that some of the symptoms associated with stuttering can be accounted for within a model of speech developed to account for normal hesitations, speech errors, and self-corrections (e.g., Levelt, 1983).

In this chapter, we provide initial evidence that stutterers appear to be oversensitive when assessing disfluencies common to both nonstuttering and stuttering speakers. Our research supports a view (Vasic and Wijnen, this volume) which emphasises the role of self-monitoring in the production of stuttered speech.

1.Self-monitoring in stuttering

Self-monitoring can be described as "the process of inspecting one's own speech and taking appropriate action when errors are made" (Hartsuiker & Kolk, 2001). Levelt's (1983, 1989) theory assumes that both overt speech and an internal speech plan are monitored. Postma (2000) summarises a number of common speech errors and identifies evidence for two types of self-monitoring: overt speech repairs (where speakers correct themselves mid-utterance) support the monitoring of external speech, whereas covert repairs (where there is no overt error, but a repair can be inferred from a hesitation in the speech output) supply evidence for the internal monitor. In fact, evidence suggests that the repair is often ready before the error is articulated (e.g., Blackmer & Mitton, 1991), and that errors can be made in the absence of articulatory activities or spoken output (for example, when imagining that one is articulating a tongue-twister: Dell & Repka, 1992). Thus the self-monitoring system would appear to have components which are distinct from the monitoring of motor systems (such as articulation) and from the auditory channel. Importantly, the speech that we produce has *already* been affected by self-monitoring; there is no external record of the original, possibly imperfect, speech plan.

Recent theorists have taken this view on board. For example, Postma & Kolk (1993) hypothesise that stuttering results from covert detection and correction of errors in the articulatory plan through the internal self-monitor. Covert self-correction would prevent the speech error from becoming overt, but would, as a side-effect, compromise the fluency of speech. Evidence for this Covert Repair Hypothesis is inconclusive (for details see: Hartsuiker, Kolk and Lickley, this volume; Vasic and Wijnen, this volume), but still supported by current studies (e.g. Melnicke, Conture and Ohde, this volume, who suggest that not only phonological encoding, but syntactic and semantic processes may be impaired in the formulation of speech by children who stutter).

Blackmer and Mitton (1991) also ascribe a role to monitoring. According to these authors, rapid subsyllabic repetitions, a key symptom of stuttering, occur when the monitor detects a lack of input, and consequently 'restarts' previous articulatory movements.

More recently, Wijnen (2000; Vasic & Wijnen, this volume) has placed the emphasis entirely on the self-monitoring system, by proposing that stuttering is the direct result of an overvigilant monitor. Paradoxically, the repairs made often introduce disfluencies rather than prevent them: "stutterers stutter because they try to avoid it" (Wijnen, 2000). Such a view can be easily extended to account for aspects of stuttering such as context-dependency and linguistic distribution.

These proposals have in common the assumption that stuttering is related to self-monitoring; they also share, to a greater or lesser degree, the entailment that there is a continuity between stuttered and normal disfluencies (in contrast to, e.g., Perkins, 1995). Arguably, the most parsimonious view is that of Vasic and Wijnen (this volume); since there are no differences in planning processes (Postma & Kolk, 1993) or timings (Blackmer & Mitton, 1991) between stutterers and nonstutterers, all differences between the two groups must be attributed to the self-monitor. Given an appropriate experimental paradigm, we should be able to find direct evidence for the self-monitor's sensitivity in those who stutter. By a similar process of inference, we would expect there to be continuity between the speech of stutterers and nonstutterers: it is not errors in planned speech, but how many repairs are initiated, which differentiates the two groups.

2.Sensitivity of the self-monitor

According to Vasic and Wijnen, there are three specific ways in which the speech monitor may be 'over-sensitive' to (potential) speech errors. Firstly, too much cognitive effort may be invested in monitoring. Secondly, the focus (as distinct from effort) of the monitoring system may be rigid and unadaptive. Thirdly, the threshold of the monitor may be too low: a 'hypersensitivity' to minor speech distortions that non-stutterers would tolerate (or in other words regard as within the bounds of 'normal' speech) increases the likelihood of stuttering. The first two assertions are addressed in Vasic and Wijnen's chapter; in this chapter we focus on the third.

There are three basic proposals for the nature of the self-monitoring system. The first (Levelt, 1983, 1989) supposes that the mechanisms (at the conceptual, phonetic, and auditory levels) which understand language produced by others are shared with the self-monitoring system. The second (Laver, 1973, 1980) assumes multiple monitoring devices attuned specifically to production, including the potential to monitor the articulatory motor processes themselves. A third view (MacKay, 1987, 1992a,b) suggests that error awareness arises from the prolonged activation of otherwise uncomitted nodes in the system for speech production. In an extensive review, Postma (2000) concludes that current evidence largely favours the view of Levelt (1983, 1989) in which the systems responsible for language perception and for self-monitoring are shared. If we accept this view, then people who stutter should show increased sensitivity to disfluencies in others', as well as their own, speech. In the simplest case, this sensitivity would be manifest whatever the provenance of the disfluent speech -- i.e., whether it is uttered by a stutterer or a nonstutterer.

The current study addresses this issue by eliciting, from a group of stutterers and a comparison group of non-stutterers, ratings of the 'severity of disfluency' of recorded speech fragments. The fragments are excerpted from recordings made of dialogues between pairs of stutterers, and between matched pairs of nonstutterers. This allows us to simultaneously address the second, continuity, assumption of many single-model accounts. Few studies have directly assessed the sensitivity of people who stutter to dysfluency in the speech of others. Postma and Kolk (1992) come close, by comparing the abilities of people who stutter and fluent subjects to detect errors (rather than disfluencies) in sequences of CV and VC syllables produced by another speaker. Their finding was that people who stutter were less successful than controls in detecting errors under these conditions. In addition, they found that the two groups did not differ in their ability to detect their own errors in the production of CV and VC sequences. The results are taken as evidence that self-monitoring via auditory feedback is not impaired in people who stutter. In our study, we ask listeners to rate severity of dysfluency, rather than error, in samples of spontaneous speech, rather than non-word strings.

3.Continuity between stuttered and normal disfluencies

To some researchers (e.g. Bloodstein, 1970), the difference between the clinical disorder of stuttering, and "normal" speech disfluency is simply a matter of degree. Stuttering is recognised by the frequency and severity of syllable-sound repetition. "There is no test for determining the precise point at which speech repetitions stop being ‘normal’ and become ‘stuttering’. We cannot specify where the wall of an igloo ends and the roof begins. It is not a scientific question” (Bloodstein, 1970). In order to strengthen his argument, Bloodstein (1970) describes what he calls the “Consistency Effect”: the distribution of disfluencies in the speech sequence is supposedly similar for stutterers and nonstutterers. Cross (n.d.) agrees that a categorical differentiation between stutterers and nonstutterers is both unnecessary and invalid, because the nature and degree of the problem vary from one individual to the next. He concludes that the issue is not whether the person is a stutterer or not, but whether the form or frequency of speech disruptions interferes with their ability to convey a message.

However, Perkins (1990) insists that a qualitative categorical distinction *does* exist between stutterers’ and nonstutterers’ speech. He suggests that there are two definitions of stuttering. The observer’s viewpoint corresponds to the continuity hypothesis, whereas the stutterer’s viewpoint corresponds to a categorical judgement. According to this perspective, speakers *know* when they stutter, but listeners can only *guess*. So, disfluency in nonstutterers is concerned with the motor control aspects of speech, whereas disfluency in stutterers seems to involve additional psychological aspects such as loss of control and feelings of helplessness.

In order to disentangle these views, the current study obtains ratings of fluent and disfluent speech fragments recorded from dialogues between stutterers and between nonstutterers. We should be able to ascertain whether there is a general distinction to be made between stutterers’ and nonstutterers’ speech, and (based on Levelt’s, 1983, view of self-monitoring outlined above) whether stutterers perceive a discontinuity where others perceive a continuum.

4.The Present Study

The present pilot study investigates the phenomenon of stuttering *perceptually*, in contrast to previous work (e.g., Vasic & Wijnen, this volume) which has posited self-monitoring accounts of stutterers’ speech *production*. In the experiment reported in this chapter, we asked judges who stuttered to rate the fluency or otherwise of short extracts from recordings made in naturalistic circumstances of dialogues between pairs of stuttering participants or pairs of nonstuttering controls. For each type of dialogue, half of the extracts were of fluent speech, and half were of mildly disfluent speech, where the onset of a word was repeated a single time. We would not expect either set of judges to rate extracts obtained from dialogues between stutterers as more disfluent *overall* than those obtained from nonstutterers' dialogues; we expect there to be little or no *qualitative* difference between the speech of the two groups. However, to test Vasic and Wijnen' s hypothesis directly, the ratings given by our judges were compared with those from a second group of judges without stutters. If Vasic and Wijnen are correct, the judges who stutter should be more sensitive to disfluency. This sensitivity could manifest itself in one of two ways: if the judges who stutter detect and are sensitive to minor infelicities in the fluent speech extracts, we might expect them to rate these (as well as the disfluent samples) as worse. On the other hand, an increased sensitivity to disfluency may make people who stutter likely to *differentiate more* between fluent and disfluent speech.

There are two justifications for the approach taken here: firstly, we avoid prejudging whether disfluent speech should be considered as 'normal' or 'stuttered', an absolute distinction which many researchers dispute; and secondly, if we accept Levelt's view that the processes responsible for self-monitoring are also responsible for the processing of others' speech, we are in a position to *directly* compare the sensitivities of stutterers and nonstutterers to disfluencies in speech. The approach relies on using a rating system which is sensitive enough to capture small differences in listeners' perceptions of the fluency of recorded speech. We have chosen to use Magnitude Estimation, an approach used increasingly in linguistic studies where fine judgements are required, which we outline below.

5.Magnitude Estimation

'Until stuttering can be identified qualitatively, we have no way of knowing what it is we have studied. Empirical evidence is needed to determine the best appropriate measures" (Perkins, 1995). The technique of Magnitude Estimation promises to be an extremely useful way of accessing fine judgements about the severity of disfluency in speech. This method was developed by psychophysicists to make the best use of participants' ability to make fine judgements about physical stimuli, and has since been used in a number of linguistic acceptability tasks (Bard et al., 1996; Keller, 2000). Participants are instructed to assign any number to a given stimulus (the Modulus), and rate the following stimuli proportionately. This can be compared to traditional 'Likert Scale' measures, where participants are asked to assign a number on a discrete scale (often 1-7). The disadvantage of such interval scaling is that there is no way of knowing in advance if people's sensitivities to the data provided are limited to a seven-way distinction any more than to a four-way one (Bard et al., 1996). In contrast, in Magnitude Estimation, raters' responses are unconstrained; categorical judgements can be revealed rather than imposed. This method has been demonstrated to result in robust but fine distinctions. In previous research on stuttering, it has been argued that Magnitude Estimation has greater construct validity than other methods (Schiavetti et al., 1983). Experience with internet studies using Magnitude Estimation (e.g., Keller & Alexopolou, 2001) demonstrates that it can be used consistently by untrained readers and listeners.

6.Method

1.Speech Corpora

All stimuli used in the experiment were unedited samples of spontaneous speech taken from task-oriented dialogues. The HCRC Map Task Corpus (Anderson *et al.*, 1991) was used as a model. In the map task, both speakers have a similar map and one speaker (instruction giver) has a route marked on their map, which they have to describe to the other (follower). Discrepancies between the two maps provide occasions for discussion and negotiation. The HCRC Map Task Corpus has proven to be a rich source of disfluent speech in nonstutterers, both as instruction giver and as follower (Branigan, Lickley and McKelvie, 1999; Lickley, 2001).

To provide natural samples of speech by stutterers, 2 dialogues involving two pairs of speakers who stutter were recorded. The stuttering speakers were recruited with the help of a local speech and language therapist and a self-help group in Edinburgh. Recordings took place in a quiet studio, with speakers sitting at tables facing each other about 5 metres apart, their maps raised on easels at an angle so that neither participant's map was visible to the other. Speakers were fitted with clip-on microphones and recorded onto separate channels on digital audio tape and SVHS video tapes.

Nonstuttering control stimuli came from two sources. The first source was the speech of two speakers from the HCRC corpus itself, which involved speakers with Scottish accents and was recorded in very similar conditions to the new corpus. These two speakers provided matches for the stimuli produced by the two Scottish stuttering speakers. Since the other two stuttering speakers were not Scottish speakers, nonstuttering speakers with very similar accents were recruited to record another dialogue, so as to counter any biasing effects of regional accent in the experiment.

The HCRC Map Task Corpus has full transcriptions and disfluency annotation time-aligned with the digitised speech signal. The new dialogues were transcribed and annotated for disfluency using signal processing software on Unix workstations. Disfluency annotation was performed with reference to the HCRC disfluency coding manual (Lickley, 1998), which was adapted to include disfluencies associated with stuttering (multiple repetitions, prolongations and blocks). The same software was used to excise the experimental stimuli from the dialogues into separate files.

2.Stimulus selection

For the purposes of the current study, we attempted to match the stimuli produced by stutterers with similar stimuli produced by nonstutterers. This strategy meant that the type of disfluency we could use in stimuli was restricted to a small subset of the types of disfluency that are produced by people who stutter: single repetitions of part words, rather than multiple repetitions. While they are a common characteristic of the speech of people who stutter, multiple repetitions are somewhat rare in the speech of nonstutterers. In the HCRC Map Task Corpus (described in Anderson *et al.*, 1991), we find nearly 2000 disfluent repetitions, only 161 of which consist of more than one repetition and only 19 of more than two. Of these, only 1 is a part-word repetition, consisting of progressively shorter repetitions of the onset of a 3 syllable word (undernea- under- und- un- no underneath).

Perceptual studies on non-stuttered speech using non-stuttering listeners suggest that minor disfluencies such as single part-word repetitions are harder to detect and more often missed altogether by listeners than other types of disfluencies (Bard and Lickley, 1998): non-stutterers, at least, appear to find such disfluencies unobtrusive.

Restricting the stimuli in our study to this type of disfluency has a bearing on our interpretation of the results. If stutterers are more sensitive even to such minor disruptions than are nonstutterers, this will serve to emphasise their over-sensitivity and support the notion that their acceptability threshold for errors is significantly higher. In addition, if we find that listeners judge these minor disfluencies differently for stutterers and nonstutterers, we will have evidence that contradicts the continuity hypothesis, suggesting that there is a qualitative difference even between the "normal" disfluencies for the two sets of speakers.

3.Materials

A total of 64 stimuli were selected from the corpora described above so as to include sets of 32 disfluent and 32 fluent stimuli. Half of these came from the 4 stuttering speakers and the other half from 4 nonstutterers. All the disfluent stimuli contained single repetitions of word onsets. Each stimulus produced by a stutterer was matched as closely as possible with a stimulus from a nonstutterer with the same regional accent. Disfluent stimuli were matched for phonetic content of the repeated segment wherever possible (e.g. "*that s-section"* was matched with "*going s-straight up"*). Fluent stimuli were matched for their lexical and syntactic content, as far as possible (e.g. "*then you go up"* was matched with "*then you go straight up"*). However, finding precisely matched controls from a small corpus of spontaneous speech is virtually impossible. Where such a precise match was not possible, the most liberal criterion used was that speech segments should be of equivalent length. No patterns likely to bias experimental outcomes could be detected in the less precisely-matched stimuli.

One stimulus, a disfluent item produced by a nonstutterer, was selected as modulus, and headed each of 3 blocks of 21 other stimuli. Apart from this stimulus, the items were presented in different random orders for each subject.

4.Subjects

Subjects in the listening experiment consisted of 16 nonstutterers (9 female, 7 male) and 6 stutterers (1 female, 5 male), with an age range of 20-45. None reported having hearing deficits. None had previous experience of the task of giving fluency judgments.

5.Procedure

The experiment was carried out using Psyscope (Cohen *et al.*, 1993) on an Apple Macintosh computer. Stimuli were played over headphones to subjects seated in sound-proofed listening booths.

Instructions were presented on the computer screen in several short sections. Subjects were told that their task was to give a numerical response which matched their perception of the severity of speech disfluency for each segment of speech that they heard. They were asked to rate *more disfluent* segments with *higher* numbers and *less disfluent* segments with *lower* numbers and to relate their judgments to their score for the modulus segment. They were encouraged not to base their ratings on anything other than fluency (e.g. speaker accent, grammaticality) and to respond as quickly as possible. Subjects responded by typing their responses on a computer keyboard. The presentation of stimuli was self-paced: a new stimulus was played when the subject hit the "return" key on the keyboard.

The experiment was preceded by a practice session to familiarise the subjects with the magnitude estimation task. The practice session consisted of judgments of tone duration, rather than line length, which is the measure usually used in magnitude estimation, in order to maintain the auditory aspect of the experiment.

Following the practice session, subjects performed the experiment without interruption, typically completing the task in about 15 minutes. Responses, consisting of typed numbers corresponding to the three repetitions of the Modulus, together with 63 other comparative ratings, were recorded in data files generated by Psyscope.

7.RESULTS

Each participant's ratings were divided by the value they had given to the modulus stimulus, to make the scores comparable. Since the ratings were ratios ('how much more or less fluent than the modulus") they were then log-transformed. A transformed rating of zero thus indicated that the participant had judged a stimulus to be equivalently fluent to the modulus; scores greater than zero indicated increased disfluency, and scores less than zero indicated that the stimulus had been rated as relatively fluent.

The analysis of the transformed scores was however made more difficult by a design flaw in the study. Participants rated each modulus three times, but no attention was drawn by the experimenters to the fact that the two repetitions should be given the initial modulus rating. This lack of 'anchoring' resulted in an appreciable drift in participants' scoring throughout the experiment; of 22 participants in total, only 5 gave the modulus item the same score on all three occasions. In other words, the results from 17 participants introduced additional, non-systematic, error variance into the study (and because the modulus ratings did not appear to change in predictable ways, there is no obvious way to compensate for this). The analysis by participants reflects these problems, and will not be reported here. However, because the experimental stimuli were randomised, each stimulus had an equal chance of occurring early in the experiment (before the onset of drift). This means that the error variance due to drift should be approximately equally partitioned across items, and a by-items analysis can be used to give a clearer picture of the outcome of the experiment.

The analysis reported here included the (matched) stimuli as a random factor, and explored the effects of rater (with or without stutter), speaker (with or without stutter), and type of utterance (fluent or disfluent) as within-item factors. All means reported are of log-transformed adjusted ratings.

Note that we can consider the stimuli used in this experiment to be a subset of the infinite population of comparable disfluencies. Thus a by-items analysis does not fall subject to the criticism of Raaijmakers, Schrijnemakers and Gremmen (1999).

Only two of the variables had independent effects: unsurprisingly, disfluent utterances were judged to be more disfluent than fluent utterances (0.10 vs. -0.57; $F(1,15) = 153.17$, $p < .001$); and speakers with stutters were rated slightly less fluent overall (0.13 vs. -0.34; $F(1,15) = 7.29$, $p = 0.003$). There was no independent effect of rater (that is, raters appeared to use similar ranges of scores, whether or not they had stutters themselves). Interestingly, there was no interaction between speaker and utterance type, suggesting that disfluent or fluent utterances from speakers with stutters were perceived equivalently to similar utterances from nonstuttering speakers; the interaction between speaker and rater, and the three-way interaction, also failed to reach significance.

However, the interaction between rater and utterance type did reach significance ($F(1,15) = 23.41$, $p < 0.001$). As can be seen from figure 1, this reflects the fact that raters with stutters differentiated more between disfluent and fluent utterances than did raters without stutters, suggesting that people with stutters discriminate more sensitively between fluent and disfluent speech. We return to this point in the discussion.

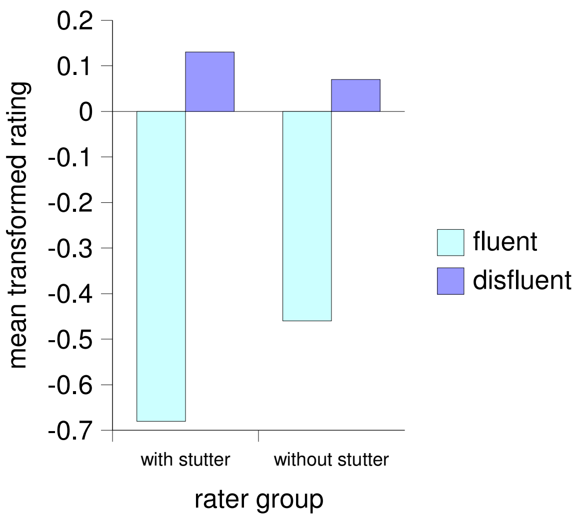

Figure 1: Mean transformed ratings of fluent and disfluent utterances by raters with and without stutters.

8.

9. Discussion

It is widely agreed that despite the inclusiveness of the label, people who are described as, or describe themselves as, stutterers often display very different symptoms and coping strategies. In this context, results from a small-scale study such as that reported here need to be treated with caution: it is too early to make any claims about a single cause of stuttering. However, taken together with the studies reported by Vasic and Wijnen, the findings from the present study converge to implicate the self-monitor in stuttering. In a direct test of sensitivity to disfluency, stutterers were found to differentiate more between disfluent and fluent speech than nonstutterers, regardless of whether that speech had been originally uttered by someone considered to have a stutter or someone who was a nonstutterer. This evidence is consistent with one interpretation of Vasic and Wijnen's hypothesis. It would be premature however to conclude that people who stutter do not rate *fluent* speech as worse; given the small numbers of participants, comparisons of *absolute* ratings between groups must be treated with caution. However, the evidence clearly indicates a difference in *relative* ratings, consistent with either version of the hypothesis; further, we can assume that since participants were explicitly instructed to rate the recordings for fluency, the focus and cognitive effort devoted to the task were maximised, and have little role to play in the outcome.

In contrast, it is important to note that the continuity hypothesis was not directly supported: excerpts from dialogues between stuttering participants were rated as worse than those from nonstutterers, regardless of whether they were fluent or not, and regardless of who was doing the rating. In fact, there is evidence that both the disfluent and the fluent speech of stutterers may involve abnormal motor activity, both in laryngeal dynamics (e.g., Adams *et al.,* 1985) and in the supralaryngeal organs (Wood, 1995). Using electropalatography, Wood found that stutterers produced greater degrees of lingual-palatal contact while producing alveolar plosives in fluent speech than did nonstutterers. It seems likely that such indications of muscular tension in the speech production apparatus (for example "hard contacts" in Van Riper's

(1982) terms) may be perceptible to listeners. If they were present in our experimental materials, subjects may have reflected this in their fluency judgements. In itself, this supposition does not contradict a self-monitor based explanation of stuttering: sensitivity to the likelihood of stuttering, and a hypersensitivity to potential repairs, may be reflected in motor activity.

The study reported here is also limited in that it only addresses onset repetitions: one of several symptoms associated with stuttering. One reason for investigating repetitions first is because the silent interval can be measured objectively, and can therefore be used as a reliable measure of stuttering for clinicians (stutterers tend to have a shorter silent interval). Although Wijnen (2000) argues that the Vicious Circle hypothesis also applies to other symptoms such as prolongations and blocks, further research is needed before we are able to rule out counterexplanations of these manifestations. Another limitation is the number of subjects in this study: we are addressing this in a larger study currently nearing completion.

In contrast to the more ‘objective’ view presented here, Perkins (1995) claims that it is the speaker’s feelings of loss of control over their speech that truly defines stuttering, rather than particular types or frequencies of disfluencies. He argues that taking averages of averages and trying to obtain a quantitative description of an essentially qualititative issue loses most of the sensitivity and original quality of the data. The issue of subjectivity is of crucial importance in this area of research – to what extent can the diverse speech behaviour of stutterers be quantified in controlled experiments? We would contend that using a sufficiently sensitive task such as Magnitude Estimation avoids some of the pitfalls that Perkins envisages, and allows us to make important insights into the nature of stuttering. This approach has little to say about the pathology of stuttering (as yet, there is no account of what *causes* hypersensitivity in the self-monitor), but much to say about its manifestation, and by implication, about some possible therapeutic approaches. In particular, the findings reported here and in Vasic and Wijnen’s earlier chapter suggest that stuttering may be ameliorated by encouraging clients to tolerate, rather than attempt to avoid, the speech errors that all speakers are prone to make.

10.References

Adams, F.R., Freeman, F.J., & Conture, E.G., (1985). Laryngeal dynamics of stutterers. In R.F. Curlee, W.H. Perkins, (Eds.), *Nature and treatment of stuttering: New directions.* San Diego, CA: College-Hill Press.

Anderson, A.H., Bader, M., Bard, E.G., Boyle, E., Doherty, G., Garrod, S., Isard, S., Kowtko, J., McAllister, J., Miller, J., Sotillo, C., Thompson, H. & Weinert, R. (1991). The HCRC Map Task Corpus. *Language and Speech*, 34, 351-366

Bard, E.G. & Lickley, R.J. (1998). Graceful Failure in the Recognition of Running Speech. Proceedings of The 20th Annual Meeting of the Cognitive Science Society, University of Wisconsin-Madison, USA, pp.108-113.

Bard, E.G., Robertson, D. & Sorace, A. (1996). Magnitude estimation of linguistic acceptability. *Language*, Vol. 72, No. 1, 32-68,

Blackmer, E.R., & Mitton, J.L. (1991). Theories of monitoring and the timing of repairs in spontaneous speech. *Cognition, 39,* 173-194.

Bloodstein, O. (1970). Stuttering and normal nonfluency: A continuity hypothesis. *British Journal of Disorders of Communication*, 1970, 30-39.

Branigan, H., Lickley, R.J. & McKelvie, D. (1999). Non-linguistic influences on rates of disfluency in spontaneous speech. Proceedings of the ICPhS, International Congress on Phonetic Sciences, San Francisco, pp 387-390.

Cohen, J.D., MacWhinney, B., Flatt, M. & Provost, J. (1993). Psyscope: A new graphic interactive environment for designing psychology experiments. *Behavioral Research Methods, Instruments, and Computers*, 25 (2), 257-271.

Cross, D.E. (n.d.) *A systems approach to stuttering.* Retrieved 30 October, 2002, from http://www.ithaca.edu/cross/SPECIALIZATIONS/STUTTERING/Stuthome.html

Dell, G.S. and Repka, R.J., (1992). Errors in inner speech. In B.J. Baars (Ed.), *Experimental slips and human error: Exploring the architecture of volition.* New York, NY: Plenum Press.

Hartsuiker, R.J., & Kolk, H.H.J. (2001). Error monitoring in speech production: A computational test of the perceptual loop theory. *Cognitive Psychology, 42,* 113-157.

Hartsuiker, R.J., Kolk, H.H.J. & Lickley, R.J. (2003). Stuttering on function words and content words: A computational test of the Covert Repair Hypothesis. In R.J. Hartsuiker, R. Bastiaanse, A. Postma, & F. Wijnen (Eds.), *Phonological encoding and monitoring in normal and pathological speech.* Hove (East Sussex): Psychology Press.

Keller, F. (2000). Gradience in grammar: Experimental and computational aspects of degrees of grammaticality. Unpublished doctoral dissertation, University of Edinburgh.

Keller, F. & Alexopoulou, T. (2001). Phonology competes with syntax: Experimental evidence for the interaction of word order and accent placement in the realization of information structure. *Cognition, 79*, 301-372.

Laver, J.D.M., (1973). The detection and correction of slips of tongue. In V.A. Fromkin (Ed.), *Speech errors as linguistic evidence.* The Hague: Mouton.

Laver, J.D.M., (1980). Monitoring systems in the neurolinguistic control of speech production. In V.A. Fromkin (Ed.), *Errors in linguistic performance: Slips of the tongue, ear, pen, and hand.* New York, NY: Academic Press.

Levelt, W.J.M. (1983). Monitoring and self-repair in speech. *Cognition, 14,* 41-104.

Levelt, W.J.M. (1989). *Speaking: From intention to articulation.* Cambridge, MA: MIT Press.

Lickley, R.J. (1998). HCRC Disfluency Coding Manual. HCRC Technical Report. HCRC/TR-100, Human Communication Research Centre, University of Edinburgh.

Lickley, R.J. (2001). Dialogue Moves and Disfluency Rates. In *Proceedings of DiSS '01, Disfluency in spontaneous speech,* ISCA Tutorial and Research Workshop, University of Edinburgh, pp 93-96.

MacKay, D.G. (1987). *The organization of perception and action: a theory for language and other cognitive skills.* New York, NY: Springer.

MacKay, D.G. (1992a). Awareness and error detection: New theories and research paradigms. *Consciousness and Cognition, 1*, 199-225.

MacKay, D.G. (1992b). Errors, ambiguity, and awareness in language perception and production. In B.J. Baars (Ed.), *Experimental slips and human error: Exploring the architecture of volition.* New York, NY: Plenum Press.

Melnick, K., Conture, E. & Ohde, R. (2003). Phonological Encoding in Young Children who Stutter. In R.J. Hartsuiker, R. Bastiaanse, A. Postma, & F. Wijnen (Eds.), *Phonological encoding and monitoring in normal and pathological speech.* Hove (East Sussex): Psychology Press.

Perkins, W.H. (1990). What is stuttering? *Journal of Speech and Hearing Disorders*, *55,* 370-382.

Perkins, W.H. (1995). *Stuttering and science*. San Diego, CA: Singular Publishing Group.

Postma, A. (2000). Detection of errors during speech production: a review of speech monitoring models. *Cognition, 77,* 97-131.

Postma, A. and Kolk, H.H.J. (1992). Error monitoring in people who stutter: Evidence against auditory feedback defect theories. *Journal of Speech and Hearing Research, 35,* 1024-1032.

Postma, A. & Kolk, H. (1993). The covert repair hypothesis: Prearticulatory repair processes in normal and stuttered disfluencies. *Journal of Speech and Hearing Research*, *36,* 472-487.

Raaijmakers, J.G.W., Schrijnemakers, J.M.C., & Gremmen, F. (1999). How to deal with "The language-as-fixed-effect fallacy": Common misconceptions and alternative solutions. *Journal of Memory and Language, 41,* 416-426.

Schiavetti, N., Sacco, P.R., Metz, D.E., & Sitler, R.W. (1983). Direct magnitude estimation and interval scaling of stuttering severity. *Journal of Speech and Hearing Research*, 26, 568-573.

Vasic, N. & Wijnen, F. (2003). Stuttering as a monitoring deficit. In R.J. Hartsuiker, R. Bastiaanse, A. Postma, & F. Wijnen (Eds.), *Phonological encoding and monitoring in normal and pathological speech.* Hove (East Sussex): Psychology Press.

Van Riper, C. (1982). *The Nature of Stuttering*. Englewood Cliffs, NJ: Prentice-Hall.

Wijnen, F. (2000). Stotteren als resultaat van inadequate spraakmonitoring [Stuttering as the result of inadequate speech monitoring]. *Stem-, Spraak- en Taalpathologie, 9.*

Wood, S. (1995). An electropalatographic analysis of stutterers' speech*European Journal of Disorders of Communication, 30,* 226-236.