Exploring the relationships between perfectionism, speech-monitoring and disfluency in the speech of people who do and do not stutter

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Declaration

I hereby declare that this dissertation is of my own composition, and that it contains no material previously submitted towards the award of any other degree. The work reported in this dissertation has been executed by myself, except where due acknowledgement is made in the text.

14,063 words excluding references and appendices.

Abstract

This study investigates the hypothesis that domain-general perfectionism, as measured by the Frost Multidimensional Perfectionism Scale (FMPS: Frost, Marten, Lahart, & Rosenblate, 1990), is associated with hyper-vigilant speech monitoring, and with raised levels of disfluency in both normal and stuttered speech. It consists of two parts: (1) an online survey of perfectionism in people who stutter; and (2) a tongue-twister experiment conducted on people who do not stutter. The tongue-twister experiment included an auditory-masking condition which enabled an assessment of the impact of reduced speech-monitoring on participants' disfluency rates. In the online survey both stuttering and stuttering participants' self-ratings of difficulty speaking fluently were found to be associated with raised *Concern over Mistakes* and low *Personal Standards* FMPS subscale self-ratings. In the tongue-twister experiment, in which disfluency rates were measured directly, corresponding correlations were not found and, although participants' disfluency rates overall were significantly reduced when auditory masking was applied, the size of the reduction was not modulated by their perfectionism ratings. It was concluded that (1) the perfectionism self-ratings provided by respondents who stutter in the online survey were likely to have reflected their attitudes and beliefs that related specifically to speaking and thus did not constitute evidence of a link between domain-general perfectionism and stuttering or disfluent speech; and (2) less vigilant monitoring improves the overall quality of speech irrespective of whether or not speakers are perfectionists. The potential clinical implications of these findings are discussed.

Contents

Introduction

The possibility that a perfectionistic approach towards speech may play a role in the development of stuttering has been suggested by a number of researchers over the years (e.g. Froeschels, 1948; Johnson, 1942; Riley & Riley, 1980; Vasić & Wijnen, 2005) and has formed the basis of at least one of the major theories of stuttering.

A survey of domain-general attitudes and beliefs by Amster (1995) using the Burns Perfectionism Scale (Burns, 1980) and a recent clinical study by Amster and Klein (2006 &2008) have, however, provided some preliminary evidence suggesting that, in people who stutter, this perfectionistic approach to speech may itself be sustained by broader, domain-general perfectionistic attitudes and beliefs, and that domain-general perfectionism may thus be an important contributory factor in the persistence of stuttering.

The motivation for the current study was thus to provide further evidence to clarify the extent to which domain-general perfectionism may predispose speakers to stuttering, as well as to raised levels of "normal" (i.e. non-stuttered) disfluencies.

A further aim of the current study was to attempt to integrate the evidence of a link between perfectionism and stuttering with evidence from a number of studies (Kamhi & McOsker, 1982; Russell, Corley & Lickley, 2005; Vasić & Wijnen, 2005) suggesting a link between disfluencies (in both normal and stuttered speech) and hyper-vigilant monitoring of speech, and in particular to investigate whether the vigilance with which speakers monitor their speech may be related to the extent to which they are concerned about making mistakes.

The nature of perfectionism

Although, on a superficial level, perfectionism has been be equated with the setting of very high standards of personal performance (e.g. Burns, 1980; Frost, et al., 1990; Hollender, 1965) and with a striving for flawlessness (Flett and Hewitt, 2002), on a deeper level the concept is more difficult to pin down and, as yet, no universally agreed definition of it has been arrived at. Hollender (1965, p95) regarded it as a personality trait that "blends with or is butressed by other traits". More recently it has come to be considered as a multi-dimensional construct, involving a network of beliefs, attitudes, ideals and expectations (e.g. Frost et al., 1990; Hewitt & Flett, 1991) the origins of which have been attributed to demanding and conditional parenting styles (Burns, 1980; Frost, Lahart, & Rosenblate, 1991).

In some circles, for example in the world of performing arts, perfectionism is regarded in a positive light and associated with outstanding achievements. More often, however, and especially from the perspective of psychopathology, it is associated with a tendency to consistently overestimate how well an action has to be performed in order for it to fulfil its intended purpose. In this regard Hollender (1965, p94) defined it as the practice of "demanding of oneself or others a higher quality of performance than is required by the situation" although, as he points out, this definition is only useful insofar as there is a consensus regarding what really is required by the situation.

Because of their high standards, perfectionists may be prone to experiencing high levels of anxiety and fear, as well as frequent feelings of failure and inadequacy. Flett & Hewitt (2002) have suggested that, perhaps, the more domain-general perfectionism becomes, the more likely it is to cause difficulties, and that perfectionism is most likely to become maladaptive when it becomes global and over-generalized.

Terry-Short, Owens, Slade and Dewey (1995) have suggested that a distinction be made between *positive perfectionism*, characterised by positive strivings and maintained primarily by positive reinforcement, and *negative perfectionism*, characterised by an emphasis on the desire to avoid adverse outcomes; and a recent review by Stoeber and Otto (2006) concluded that there is strong evidence that positive strivings (as exemplified by high personal standards) are associated with adaptive behaviour. However, the suggestion that a fear of negative consequences (as exemplified by high levels of concern over mistakes) is a necessarily a maladaptive trait has been questioned (Flett & Hewitt, 2006).

The clinical consequences of maladaptive perfectionism are widespread and it has been identified as an important factor behind a number of common pathological conditions including, amongst others: depression, anxiety disorders, eating disorders, obsessive-compulsive disorders and suicidal tendencies (see Shaffran & Mansell, 2001 for a review).

Perfectionism, disfluency and stuttering

With the exception of the two studies by Amster (1995) and Amster and Klein (2006 & 2008), virtually all research into the relationship between perfectionism and stuttering had focussed solely on the effects of high standards and expectations specifically in relation to speech. By far the most influential theory to have been proposed in this area is Johnson's (1942) *Diagnosogenic Theory*. Central to Johnson's theory are the hypotheses that stuttering begins when a child notices his parents reacting negatively to his speech, and becomes firmly established in a child when he internalises his parents' belief that his speech should be more fluent, or more perfect than it is.

With regards to parental attitudes and styles of parent-child interaction, the evidence for Diagnosogenic Theory is, however, inconclusive. Thus, although the findings of a number of early studies suggest that parents have unrealistic expectations regarding the level of fluency young children should be capable of (e.g. Bloodstein, Jaeger, & Tureen, 1952; Johnson, 1959) a more recent, and detailed study by Meyers and Freeman (1985) failed to find any firm evidence in support Johnson's (1942) claims. Similarly, reviews by Nippold and Rudzinski (1995) and Yairi (1997) both concluded that there was no firm evidence to support a causal link between parental attitudes or speaking styles and the onset or persistence of stuttering in children. Nevertheless, the question continues to be debated.

A more general notion, implicit in Johnson's (1942) Diagnosogenic Theory, that has been more widely accepted, is that stuttering arises as an unintended side-effect of trying not to stutter. A number of potential mechanisms have been proposed to explain this apparent paradox, the best known being Sheehan's (1953) *Approach-Avoidance Conflict Hypothesis* and Bloodstein's (1972) *Anticipatory Struggle Hypothesis.* However, neither of these specifies in any detail why such struggles and conflicts should result in the specific types of repetitions, prolongations and tense-pauses that are characteristic of persistent stuttering.

More recently, a number of psycholinguistic hypotheses have been proposed that do specify in detail possible mechanisms behind such stuttering-like disfluencies. These hypotheses consider these disfluencies (both in people who stutter as well as in normally fluent speakers) to arise as a by-product of the functioning of various speech quality-control mechanisms. The two most widely cited hypotheses of this type are the *Covert Repair Hypothesis*, (Postma and Kolk, 1993) and the *EXPLAN* Hypothesis (Howell & AuYeung, 2002). The Covert Repair Hypothesis posits that stuttering-like disfluencies arise as a side-effect of speakers' attempts to repair errors in their speech plans, perceived through the monitoring of inner-speech prior to overt articulation.

The *EXPLAN* Hypothesis (Howell & AuYeung, 2002) posits that disfluencies arise because, when planning difficulties arise, an autonomous restart mechanism causes words or part-words that have already been planned to be repeated or prolonged, thus reducing silent pauses. In a further elaboration of the hypothesis, Howell (2003) suggested that the activation-threshold that speech plans need to attain before they can be released for articulation rises and falls depending on the level of accuracy that the speaker believes is needed in the particular circumstances in which he is speaking. Thus a perfectionistic attitude towards speech may lead to the setting of an unrealistically high release threshold and a consequent disruption to fluency[1].

Although the causes of stuttering-like disfluencies posited by the above two hypotheses are quite different, they both imply that stuttering, and indeed disfluencies in general, arise as a result of speakers' attempts to ensure a certain minimum error-free standard of speech; and they both predict that disfluency rates are likely to increase whenever speakers attempt to reduce their (overt) speech-error rates.

These hypotheses also predict that the exact nature of the relationship between disfluency rates and speakers' attempts to minimise their speech-errors is dependent on a number of additional factors, including time-pressure, and the need to avoid silent pauses in order to retain one's conversation turn. Speakers also need to adopt strategies that make optimal use of the limited processing resources available to them. Thus, in everyday life speaking situations may arise where speakers are faced with the need to make trade-offs. For example: (1) to maintain fluency and accuracy, the speaker may need to adopt a much reduced speech-rate with relatively long pauses between words; (2) to speak fluently and fast, speakers may have no choice but to allow relatively large numbers of errors; and (3) to speak accurately and without pauses, for example when there is competition for the conversation-turn, speakers may have no choice but to frequently repeat words or part words.

It is when attempting to speak both quickly and accurately without pauses that the Covert Repair and EXPLAN hypotheses predict that speakers are likely to

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[1] Raising the articulatory buffer release-threshold minimises the chances of speech-plans being wrongly encoded, and thus reduces the likelihood that overt speech will contain errors. However, it also has the side-effect of slowing the rate at which the plans become available for articulation and thus increases the likelihood of disfluency, especially if the speaker is simultaneously trying to maintain a reasonably fast speech-rate.

produce the largest numbers of disfluencies. Similarly, with respect to stuttering, these two hypotheses both make the assumption that people who stutter have a tendency to regularly attempt to speak both more quickly and accurately than they are able.

Postma and Kolk (1993) have posited that this tendency of people who stutter to try to speak more quickly/accurately than they are able arises because they have underlying impairments of their language production systems that make them prone to producing an inordinately large number of speech errors even when just trying to maintain a speech-rate that would be normal for unimpaired speakers. Thus although, theoretically, they could speak more accurately and fluently by adopting an extremely slow speech rate, in practice, the pressure to maintain their conversational turn and to keep up with their peers prevents them from doing so.

A number of studies of the linguistic abilities of young children who stutter have produced evidence in support of this impaired language-processing explanation (See Bernstein Ratner, 1997 and Conture, Zackheim, Anderson, & Pellowski, 2004 for reviews). However, with respect to adults who stutter, the evidence is more equivocal and, although minor or subtle language production impairments have been found in adults, it is difficult to see how these could result in the sometimes high and debilitating levels of disfluency that characterise persistent stuttering (See Brocklehurst, 2008 for a review).

The lack of firm evidence of language production impairment in adults who stutter led Vasić and Wijnen (2005) to suggest, instead, that adults who stutter are simply hyper-vigilant in their monitoring for errors and that this hyper-vigilance leads them to identify and attempt to repair many very minor, sub-phonemic or prosodic errors that do not need to be repaired. They thus try to speak more accurately than is really necessary. Such hyper-vigilant monitoring may also lead speakers to interpret disfluencies as "errors" that need to be repaired, causing a "vicious circle" to develop which results in the types of severe breakdown in fluency that characterise stuttering.

Vasić and Wijnen (2005) have further suggested that this tendency towards hyper-vigilant monitoring may have been instilled during childhood, perhaps because of frank impairments of their language production mechanisms that existed at that time, or perhaps, as proposed by Johnson (1942) because their parents repeatedly drew their attention to their errors and disfluencies.

Hyper-vigilant monitoring and perfectionism

Although the developmental explanations of hyper-vigilant monitoring proposed by Vasić and Wijnen (2005) sound plausible, they do not explain why children who stutter do not all spontaneously recover once they are free from parental influences and have outgrown any early language impairments; and why, in approximately 20% of cases, stuttering continues into adulthood (Bloodstein, 1995).

It is in relation to this question in particular, that the survey of perfectionistic attitudes and beliefs conducted by Amster (1995) is of interest. Specifically, when considered from this psycholinguistic perspective, Amster's (1995) findings suggest that perhaps deeper and more pervasive domain-general perfectionistic traits may cause (or pre-dispose people to) hyper-vigilant monitoring and thus play important roles in the persistence of stuttering beyond early childhood. Further support for this hypothesis has recently been provided by clinical study by Amster and Klein (2006; 2008) that demonstrated that when adults who stutter underwent short courses of Cognitive Behavioural Therapy, focussing on issues related to perfectionism, both their perfectionism ratings and stuttering rates, as measured by the Stuttering Severity Instrument (SSI-3: Riley, 1994), decreased. [2]

The Current Study

The motivation for the current study was to provide further evidence to clarify the nature of the relationship between the perfectionism as a domain-general trait and the occurrence of disfluencies in both stuttered and normal speech. The study was conducted in two parts: (1) an online survey which attempted to reproduce and extend Amster's (1995) findings, using the more comprehensive Frost Multi-dimensional Perfectionism Scale (FMPS: Frost, et al., 1990); and (2) a tongue-twister experiment, to investigate (a) whether the dimensions of perfectionism that predicted stuttering and stuttering severity in the online survey respondents also predict differences in disfluency rates (and associated speaking strategies) in a group of non-stuttering participants; and (b) whether they also predict the vigilance with which participants monitor their speech.

[2] This decrease in stuttering rate was achieved initially in the absence of any therapy directly aimed at stuttering itself.

The online survey

Introduction

The online survey was designed to replicate and extend the findings of the Amster (1995) survey by using the, more comprehensive, Frost Multidimensional Perfectionism Self-rating Scale (Frost et al., 1990). The FMPS enables a fine-grained analysis of perfectionism to be made on the basis of respondents' ratings in six perfectionism subscales. Using regression analyses, two questions were addressed: (1) can the *presence or absence* of stuttering in a group of adults who stutter and age-matched controls be predicted on the basis of their 6 FMPS perfectionism subscale ratings? and (2) Can the *severity of disfluency* experienced by stuttering respondents be predicted on the basis of their 6 FMPS subscale self-ratings?

Design Choices

The choice of perfectionism measure

Amster (1995) and Amster and Klein (2006 & 2008) made use of the Burns Perfectionism Scale in their studies. This scale was originally developed as a measure of theoretical constructs believed to underlie depression and thus focuses mainly on investigating the level at which participants set their personal standards and the extent to which they are concerned about the mistakes they make. It contains 10 statements to which respondents indicate the strength of their agreement or disagreement using 5-point Likert scales. The responses are then summed to give a mono-dimensional perfectionism score.

In the early nineties, two large-scale studies of perfectionism in students led to the development of two new multidimensional perfectionism scales: The *Frost Multidimensional Perfectionism Scale* (FMPS: Frost et al., 1990), and the *Hewitt and Flett Multidimensional Perfectionism Scale* (MPS-HF, Hewitt & Flett, 1991).

The FMPS defines perfectionism in terms of six underlying factors: (1) Concern over mistakes; (2) Personal standards; (3) Personal expectations; (4) Parental criticism; (5) Doubts about actions; and (6) Organisation. High Doubts about Actions and Concern over Mistakes subscale self-ratings have subsequently been confirmed to be associated with self-reported depression (Frost et al., 1993; Frost & DiBartolo, 2002); clinically diagnosed eating disorders (Minarik & Ahrens, 1996; Sassaroli et al, 2008); and Beck Depression Inventory (BDI: Beck, Steer, & Garbin, 1988) scores in patients with major depressive disorder (Enns & Cox, 1999). Other specific patterns of FMPS subscale scores have also been shown to be associated with Social Phobia (Juster et al., 1996) and Obsessive Compulsive Disorder (Frost & Steketee, 1997; Sassaroli et al, 2008).

Following a study of patients with a variety of anxiety disorders, Antony, Purdon, Huta, and Swinson, (1998, p1271) concluded "Analyses suggested that the FMPS has similar psychometric properties in clinical samples to those in nonclinical samples, and factors very similar to those observed by Frost et al. (1990) could be extracted". It thus appears that the 6 FMPS perfectionism subscales are relatively stable and reliable.

The Hewitt and Flett (1991) MPS-HF scale divides perfectionism into just 3 subscales: (1) self-oriented perfectionism, (2) other-oriented perfectionism; and (3) socially prescribed perfectionism. This scale has since also been tested on a number of psychiatric populations, including patients diagnosed with depression, alchoholism and schizophrenia with whom the construct validity has also been found to be stable and reliable (Hewitt, Flett, Turnbull-Donovan, & Mikail, 1991).

Out of the scales outlined above, we decided that the FMPS had the greatest potential to provide meaningful information regarding the relationship between perfectionism and disfluency. Firstly, the subscales *Parental Expectations* and *Parental Criticism* have the potential to inform on the validity of Johnson (1942) and Vasić and Wijnen (2005) suggestion that parental responses may play a key role in the onset of stuttering. Secondly, the subscales *Concern over Mistakes, Doubts about Actions* and *Personal Standards* each have the potential to highlight subtly different motives for being vigilant (or hyper-vigilant) with regards to speech errors. And finally, because the FMPS subscales *Concern over Mistakes* and *Personal Standards* have been found by Frost et al. (1990)[3] to be highly correlated to the Burns Perfectionism Scale, using the FMPS in the current study allows relatively direct comparisons to be made with the findings of Amster (1995).

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[3] In a group of 84 female undergraduate psychology students, Frost et al (1990) found the Burns scale to be most strongly correlated with the Concern over Mistakes (r = .866 p<0.01) and Personal Standards (r = .529, p <.01) subscales of the FMPS.

Measuring the severity of disfluencies in respondents who stutter

There are a number of adult stuttering self-rating scales commonly used by therapists in clinical settings. (e.g. Johnson, Darley & Spriestersbach, 1952; Riley, Riley & Maguire, 2004; Wright & Ayre, 2000; Yaruss & Quesal, 2006) all of which ask respondents a range of questions relating not only to disfluency but also to secondary behaviours, feelings, attitudes and beliefs. The range of questions reflects the fact that persistent stuttering is a condition that is characterised not only by actual disfluency but also by fear or avoidance of words and situations.

Because the present study was concerned specifically with disfluency (and not with the other secondary symptoms of stuttering) we needed to devise a way of ensuring that the self-ratings given by respondents who stutter really did reflect the severity of disfluency rather than the severity of stuttering symptoms overall. We thus decided to include two sets of questions in the questionnaires: the first relating to the level of *general communication difficulty* experienced by respondents in a variety of speaking situations commonly encountered in everyday life; and the second relating specifically to the level of *difficulty speaking fluently* in those same situations.

Of the self-rating scales investigated, the one that best covered general communication difficulty was Section 3a of the Overall Assessment of the Speaker's Experience of Stuttering (OASES: Yaruss & Quesal, 2006). It comprises 10 questions about general communication difficulty in 10 commonly encountered speaking situations including, for example: *talking with another person one to one; initiating conversations; speaking to strangers;* and *continuing to speak regardless of how your listener responds to you*. To collect the data referring to disfluency we drew up a parallel set of 10 questions that asked specifically about difficulty speaking fluently in the same 10 situations. Asking the 10 general communication-difficulty questions first ensured that it was completely clear to respondents that the second set of 10 questions referred only to difficulty speaking fluently.

Method

Questionnaires

Using the tools provided by the commercial online survey website www.quia.com, two versions of the survey were made available online: one for people who stutter and the other for non-stuttering controls.

Both versions of the survey began with the 35 questions of the FMPS, to which respondents were asked to select the most appropriate response from a 5-point Likert scale ranging from *strongly disagree* to *strongly agree*. Both versions also included the 10 OASES questions about general communication difficulty.[4] This was followed, in the version of the questionnaire for people who stutter, by the 10 additional questions relating specifically to difficulty speaking fluently and then by a series of (free response) biographical questions relating to the onset of stuttering and history of therapy. The control questionnaire omitted the questions relating to disfluency and stuttering, and instead simply asked respondents to give details of any conditions or disorders they have had that have affected the ease with which they are able to speak. Finally both questionnaires asked for general biographical details.

Respondents

Respondents who stutter were contacted through an advertisement that appeared on the British Stammering Association website. A number of stuttering self-help groups also agreed to forward email invitations to members on their mailing lists. An invitation to take part was also posted on the *"Stuttering Chat"* internet chat group[5]. The advertisements/invitations all described the survey as a "beliefs and attitudes survey" thus avoiding any specific mention of perfectionism. As an incentive, respondents were promised a summary of the research findings when they become available.

For the control group, students who had also been recruited to take part in the tongue-twister experiment were asked to complete the appropriate version of the online survey. In addition a general request was posted on the University webmail system for older respondents (30 years and over) to complete the survey in return for entry into a £20 prize draw. In all cases the survey was described as a "beliefs and attitudes survey" and specific mention of perfectionism was avoided.

Analyses

Two questions were addressed: (1) can the likelihood that a respondent belongs to the stuttering group or the control group be predicted on the basis of his/her 6

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[4] The OASES questions all made use of 5-point Likert scales ranging from *not at all difficult* to *very difficult*.

[5] http://health.groups.yahoo.com/group/stutteringchat/

FMPS perfectionism subscale ratings? and (2) can the stuttering respondents self-ratings of difficulty speaking fluently (henceforth referred to as Fluency-Difficulty ratings) be predicted on the basis of their 6 FMPS subscale ratings?

Logistic regression with the different FMPS subscale scores as predictors and stuttering/no-stuttering as the dichotomous dependent variable was employed to answer the first of these two questions and straightforward linear regression was used to answer the second. The decision to use regression analyses was made because, unlike ANOVAs and T tests, regression analyses give a clear indication of the independent contributions of each of the predictor variables to the outcome (dependent) variable. They thus enable an evaluation to be made of the independent contributions of the six FMPS sub-scale predictors to: (1) the stuttering/no-stuttering outcome and (2) the Fluency-Difficulty ratings, after their shared variance has been partialled out of the equation.

Backward stepwise methods (whereby all predictors are added to the regression model at the start, and those whose predictive contributions are insignificant are eliminated in a stepwise manner) were adopted in order to arrive at both of the final regression models. The decision to use this method was made because it was felt that there was insufficient evidence to allow a theory-motivated decision on which predictors to add to the regression model first. Field (2005) suggests that the Backward Stepwise method is especially suitable for such exploratory studies.

Results

In total, 81 properly completed questionnaires were received from people who stutter and 82 from non-stuttering controls. Unfortunately all of the non-stuttering controls were under 50 years old. Moreover the sample of stutterers contained proportionately more males. Therefore in the statistical analyses that directly compared the two groups, the 22 stutterers who were over 50 years old were excluded from the stuttering group and a random selection of 25 females were excluded from the control group [6]. This made the groups more similar (see Table 1 for details).

[6] In the other analyses, (i.e. which did not involve inter-group comparisons), all members of the group involved were included.

Nevertheless, the ratio of males to females still remained somewhat different between the two groups (stuttering group = 2.41:1, Control group = 1.59:1) Therefore to clarify the extent to which this imbalance may confound the results of any subsequent analyses, t-tests were carried out to determine whether or not the males and females differed significantly in the FMPS sub-scale ratings they provided. The analysis showed that the only significant difference was with stutterers' responses to the FMPS subscale *Organization*, in which females who stutter scored on average 3.16 points higher than males who stutter (SE =1.52, $t_{114} = 2.071$, p=.043). A similar (but not significant) trend was also found in the control group.

Table 1. Age statistics of the stuttering and control groups of respondents whose FMPS subscale ratings were compared.

	Stutterers	Controls
N.	59	57
Mean age	29.96	26.44
Median age	29	26
Std. Deviation	7.83	6.26
Minimum age	18	18
Maximum age	48	49
Interquartile Range	12	9

FMPS subscale scores

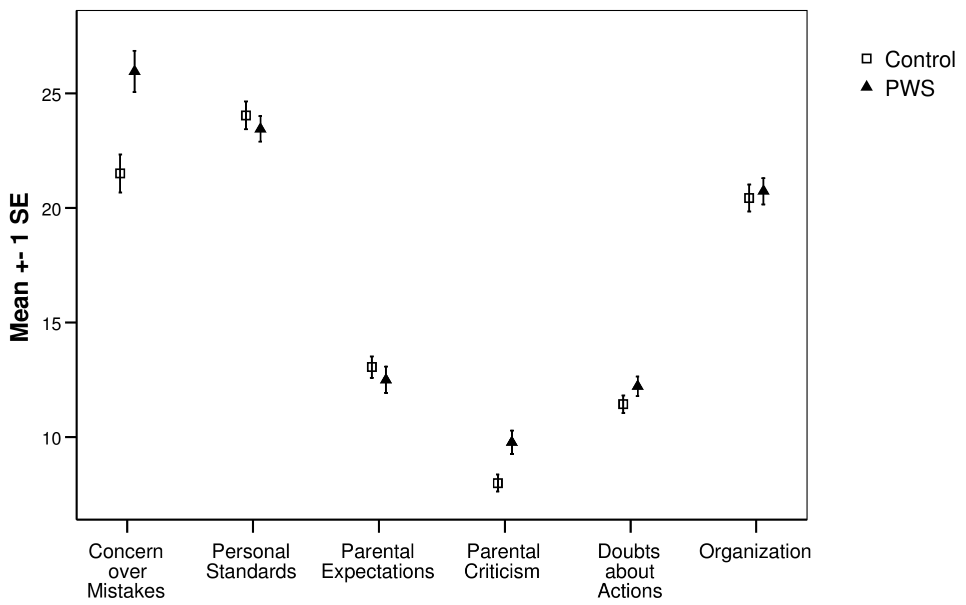
A number of the stuttering group's mean FMPS sub-scale scores were higher than those of the control group, the most notable being Concern over Mistakes, Parental Criticism and Doubts about Actions (see Figure 1).

Predicting the presence or absence of stuttering

Using backward stepwise logistic regression with Stutterer/Control as the dependent variable, and the 6 FMPS subscales as the predictors, the saturated model included Concern over Mistakes and Personal Standards as both contributing significantly to improved predictive power over the null-model (See table 2)

The exclusion of Parental Criticism and Doubts about Actions from the saturated model despite the magnitude of the differences between the two groups mean FMPS subscale scores differences (See Figure 1) occurred because they were both highly correlated with Concern over Mistakes and thus accounted for relatively little unique variance[7]. Personal Standards, however, *did* account for a significant proportion of unique variance. It is particularly noteworthy that the Personal Standards *beta* value is *negative*, indicating that stuttering is predicted by low personal standards ratings. This result is surprising insofar as it appears to contradict the conclusion of the Amster (1995) study that people who stutter have unrealistically high standards. This matter is discussed in detail in the discussion section below.

Figure 1. FMPS sub-scale self-ratings of 59 respondents who stutter (PWS) vs. 57 controls, showing mean scores and standard error (SE).



Note: Because the 6FMPS subscales each contained differing numbers of questions, the potential range of raw scores for each subscale also differed.

[7] T-test analyses of the same data showed that the differences between PWS and non-stuttering controls' scores on Concern over Mistakes, Parental Criticism, and Doubts about Actions were all significant (CM: t_{114} =4.46, p <0.001; PC: t_{114} = 2.66, p = 0.009; DA: t_{114}= 2.39, p = 0.006)

Table 2. Saturated logistic regression using FMPS subscales to predict group membership (stutterers/non-stuttering controls). (Backwards stepwise model from 6 subscales).

	B	Standard Error	Wald Z	*p*
Concern over Mistakes	.159	.037	18.469	<.001
Personal Standards	-.122	.049	6.156	.013
Constant	-.865	.989	.765	.382

Note $R^2_{(Cox\ \&\ Snell)}$ = .195; $R^2_{(Nagelkerke)}$= .260*

Improvement over the null model: χ^2=25.13 $p < .001$

Subjects: PWS n=59 Controls n=57

*note. In the Nagelkerke R^2 scale, a perfect correlation has a value of 1, whereas in the Cox and Snell scale it falls short of 1. Hence the Nagelkerke R^2 score is a closer equivalent to the R^2 in linear regressions.

Predicting difficulty communicating and difficulty speaking fluently in respondents who stutter

Because, for these two regression analyses, there was no need to compare the stutterers' data with those of controls, data from all 81 stutterers' responses were used. Two separate backwards stepwise regressions were performed, one using the OASES Difficulty Communicating score and the other using the Fluency Difficulty score as the dependent variable. Once again the predictor variables were the 6 FMPS subscales.

The results of both analyses were similar to one another although the FMPS subscales predicted more of the variance in the OASES Communication Difficulty rating (*Adjusted* R^2 =.270) than in the Fluency Difficulty rating (*Adjusted* R^2 =.101). The saturated model with the OASES- Communication Difficulty scores as the dependent variable retained the following predictors: Concern over Mistakes, Personal Standards and Organization. Doubts about actions also came close to significance and was also retained in the model. The saturated model with the Fluency Difficulty scores as the dependent variable retained Concerns over Mistakes and Personal Standards as the two significant predictors. (see tables 3 and 4)

Table 3. Saturated linear regression using FMPS subscales to predict the Communication Difficulty rating of survey respondents who stutter. (Backwards stepwise model from 6 subscales)

	B	Std. Error	Beta	t	*p*
(Constant)	18.976	3.880		4.891	.000
Concern over Mistakes	.315	.116	.349	2.709	.008
Personal Standards	-.549	.168	-.379	-3.275	.002
Doubts about Actions	.400	.226	.209	1.767	.081
Organization	.447	.148	.315	3.019	.003

Dependent Variable: communication difficulty rating

Note R^2 = .307 *Adjusted* R^2 =.270 p<.001 Subjects: PWS n=81

Table 4. Saturated linear regression using FMPS subscales to predict the Fluency Difficulty rating of survey respondents who stutter. (Backwards stepwise model from 6 subscales)

	B	Std. Error	Beta	t	*p*
(Constant)	32.296	3.992		8.091	.000
Concern over Mistakes	.365	.116	.383	3.143	.002
Personal Standards	-.460	.187	-.300	-2.462	.016

Dependent Variable: fluency difficulty rating

Note R^2 = .123 *Adjusted* R^2 =.101 p =.006 Subjects: PWS n=81

As with the earlier logistic regression, the *beta* values for the Personal Standards predictors were both negative. In both cases the strongest predictor was Concern over Mistakes, which was thus positively correlated to both the probability of belonging to the group of participants who stutter as well as (in stutterers) to difficulty communicating and speaking fluently.

Discussion

The results of the logistic regression analysis that compared the FMPS subscale ratings of the two groups of respondents demonstrate that, within those groups, (1) higher Concern over Mistakes; and (2) lower Personal Standards self-ratings, were associated with an increased likelihood of stuttering[8]. Similarly, the results of the two

[8] It should be noted that, as the two groups that were compared in the Logistic regression analysis were not randomly selected from the same population, these results cannot be generalised to the population as a whole.

linear regression analyses of the ratings given by the group of respondents who stutter showed that (1) higher Concern over Mistakes; and (2) lower Personal Standards self-ratings were associated with more (perceived) difficulty communicating and speaking fluently. The fact that the FMPS subscales predicted more of the variance in the OASES Difficulty Communicating rating (*Adjusted* R^2 =.270) than in the Fluency Difficulty rating (*Adjusted* R^2 =.101) suggests that these two scales were indeed sensitive to different aspects of the stuttering experience and that the ratings given by respondents to the Fluency Difficulty questions really did refer specifically to disfluency and not to other, secondary aspects of the stuttering experience.

To summarise, the present findings suggest that: (a) compared to normally fluent speakers, stutterers are more concerned over their mistakes but consider themselves to have lower personal standards; and (b) that amongst people who stutter, those who find it most difficult to communicate and to speak fluently are those who report high levels of concern over mistakes but low personal standards.

With respect to the Concern over Mistakes ratings, all these sets of results are fully in line with the positive correlations between perfectionism and stuttering found by Amster (1995) and perfectionism and stuttering-severity found by Amster and Klein (2006 & 2008) using the Burns Perfectionism Scale. However, the findings that *lower* Personal Standards subscale self-ratings were associated with a higher probability of being a respondent who stutters and with stutterers' higher OASES Difficulty Communicating and Fluency Difficulty scores are not in line with the Amster (1995) and Amster and Klein (2006 & 2008) findings, because the Burns (1980) scale has been found by Frost et al. (1990) to be *positively* correlated with the FMPS Personal Standards subscale (r = .529, p <.01).

Although, with respect to low Personal Standards self-ratings, this pattern of findings differs from the findings of Amster (1995) and Amster and Klein (2006 & 2008), they are similar to those of a number of studies that have used the FMPS to study the relationship between perfectionism and depression. Thus, for example, in a study of 56 undergraduates, Minerik and Ahrens (1996) found a positive correlation (r =.52, P<0.001) between Concern over Mistakes and BDI ratings but a negative correlation between Personal Standards and BDI ratings (r = – .32 p <0.05), Minerik and Ahrens (1996, p155) also noted that "those higher in depressive symptoms tended to set lower personal standards". A similar trend was also reported in a study by Frost, Heimberg, Holt, Mattia, and Neubauer (1993). These, and other similar findings, led Frost et al. (1993), Slaney, Ashby, and Trippi (1995) and Enns and Cox (1999) to propose that the six subscales of the FMPS could usefully be conceived of as falling into two distinct categories: positive and negative (i.e. adaptive and maladaptive). Thus, for example, Enns and Cox (1999) proposed that high Personal Standards and Organisation scores reflected adaptive perfectionistic traits, characterised by "positive striving", whereas high Concern over Mistakes, Doubts about Actions and Parental Criticism scores reflected maladaptive perfectionistic traits.

From this perspective, the current set of results would seem to suggest that people who stutter score highly on the negative perfectionism subscales and (with the exception of Organization) poorly on the positive.

Parental Criticism

On the basis of Johnson's (1942) Diagnosogenic Theory, which views the onset of stuttering as stemming from the critical attitudes of parents towards their children's speech errors and disfluencies, it might be predicted that respondents who stutter may be likely to score more highly on the Parental Criticism subscale than the non-stuttering controls; and indeed T-test results demonstrated that this was the case (Mean difference between the groups = 1.91, SD =0.72, t_{114} =2.66 p=0.009). It is noteworthy, however, that Parental Criticism was not one of the FMPS subscales that the (logistic) regression analysis highlighted as being predictive of stuttering group membership. The reason Parental Criticism was rejected as a significant predictor in this regression analysis was because it was highly correlated with Concern over Mistakes and thus did not account for much variance independently from that which was already accounted for by Concern over Mistakes. The implication of this is that the relatively high scores of respondents who stutter on the Parental Criticism subscale cannot be attributed specifically to parental criticism but, rather, are attributable to an unidentified underlying factor shared by both the Parental Criticism and Concern over Mistakes subscales. Such a factor may well be closely related to the Hewitt and Flett (1991) MPS subscale of *Socially Prescribed Perfectionism*, which has been found to be especially strongly correlated with both Parental Criticism and Concern over Mistakes, as well as with the Doubts about Actions FMPS subscales (Hewitt, Flett, Turnbull-Donovan, & Mikail, 1991) It is noteworthy that all of these subscales were also categorised by Enns and Cox (1999) as negative or maladaptive.

Demand Characteristics

A recognised weakness of surveys of the type conducted in the current study is that respondents' responses may have been subject to demand characteristics (Nichols & Maner, 2008). Thus for example, if respondents who stutter were open to the suggestion that stuttering and perfectionism may be linked, they may have tended to bias their responses in directions that indicate such a link. There are, however, two reasons why it is unlikely that such demand characteristics would have had an appreciable impact on the results of this particular survey: Firstly, the survey was presented as an "attitudes and beliefs" survey, rather than a "perfectionism" survey, thus avoiding any direct suggestion of a link between perfectionism and stuttering; and secondly, if such demand characteristics had caused a significant distortion, it would be expected that this distortion would have been expressed equally over all subscales in the direction of perfectionism. Thus the fact that the respondents who stutter scored significantly more highly than controls only on only two out of the six perfectionism subscales, and that stuttering severity was associated with only 3 subscales (and that not all of these were "negative" aspects of perfectionism), suggests that such demand characteristics did not play a significant role in their responses.

A second, related, possibility that may have compromised the validity of the online survey was that the respondents who stutter were invited to take part via contexts that were related specifically to stuttering (e.g. stuttering self-help groups). This raises the question as to whether or not they may have tended to respond to the FMPS questions as though they related specifically to their stuttering or speech-quality, despite the fact that the statements were really asking about performing actions in general. With regard to this possibility, it is of interest that DiLollo, Neimeyer, & Manning (2002) have suggested that because stuttering is frequently a core-construct of the identities of people who stutter, they tend, automatically, to relate events in their lives to stuttering in order to make them more meaningful. Thus it would not be surprising to find that, despite the domain-general nature of the FMPS questions, respondents who stutter did indeed tend to interpret those questions specifically in relation to stuttering and the level of fluency and overall quality of their speech. Because of this potential confound it is not possible to reliably claim that these FMPS self-ratings reflect the beliefs or attitudes of people who stutter in relation to performing actions in general rather than simply in relation to their speech.

The tongue-twister experiment

Introduction

Two questions were left outstanding from the online survey: (1) to what extent were the FMPS ratings provided by the respondents who stutter valid reflections of their attitudes and beliefs about performing actions in general?, and (2) to what extent do the patterns of FMPS subscale ratings that were found to be associated with stuttering and fluency-difficulty exert their effects by causing or predisposing speakers to hyper-vigilant monitoring of their speech?

To gain a greater insight into these issues we designed an experiment that investigated the relationship between perfectionism and disfluency in people who do not stutter. A key factor underlying the decision to use normally fluent (i.e. non-stuttering) participants in the experiment was the now substantial amount of evidence supporting the hypothesis that the mechanisms underlying the majority of stuttered disfluencies are essentially the same as those underlying the disfluencies found in the speech of people who do not stutter, and that stuttered disfluencies constitute the extreme end of a continuum of normal disfluencies (See Bloodstein, 1995 for a review of evidence for the "continuity hypothesis"). Also central to the decision to use participants who do not stutter to explore this issue was the fact that both the Covert Repair and EXPLAN hypotheses also posit that the same mechanisms underlie both stuttered and non-stuttered disfluencies.

We thus hypothesised that by placing normally fluent participants in difficult speaking situations known to result in measurable numbers of phonological errors, relationships between their FMPS subscale scores and disfluency rates should become apparent that are similar to those that were found in the respondents who stutter in the online survey. Thus high Concern over Mistakes and low Personal Standards FMPS subscale scores should predict raised levels of disfluency in normally fluent participants in just the same way as it did in the survey respondents who stutter. However, as there is no reason for normally fluent speakers to respond to the FMPS questions specifically in relation to speech or disfluency, the FMPS-subscore responses given by people who do not stutter (and whose speech and communication abilities are unimpaired) are much more likely to be "domain general". Thus, if FMPS ratings are also found to predict disfluency rates in experimental participants who do not stutter, such a finding would constitute much stronger evidence of a link between speakers' domain general attitudes and beliefs and the frequency of stuttering-like disfluencies in their speech.

On the basis of the continuity hypothesis, we also predicted that non-stutterers with FMPS self-ratings similar to those of stutterers will exhibit similar overall speaking patterns to stutterers. Thus, when left to their own devices, they will tend to speak more slowly, minimising the likelihood of making errors; whereas, if they are placed under pressure to speak quickly (in which case some errors are unavoidable) their speech will be more disfluent.[9] However, in conditions that significantly diminish their awareness of those errors, the above tendencies should diminish or even totally disappear.

The second purpose of the experimental part of the study was to test whether the FMPS subscale profile found to be associated with high Fluency Difficulty self-ratings in respondents who stutter are associated with hyper-vigilant monitoring. To do this we compared the speech error rates of experiment participants while speaking with and without auditory masking. We hypothesised that if the above FMPS subscale profile is associated with hyper-vigilant monitoring then, in participants with that FMPS profile, the application of auditory masking (which is believed to reduce the vigilance with which speakers monitor for errors (e.g. Postma & Kolk, 1992; Postma & Noordanus, 1996) should lead to a reduction in disfluencies *without* any corresponding increase in speech-errors. If, on the other hand, monitoring is not hyper-vigilant, the reduction in disfluencies should coincide with a corresponding increase in errors.

Design Choices

To test the above predictions we designed an experiment that involved three different speech-rates.

In the first condition participants were instructed to speak *"at a rate that feels comfortable"*. We predicted that, when free to choose their own speaking strategy, participants with higher Concern over Mistakes FMPS subscale scores and/or lower

[9] due to their stronger tendencies (1) to avoid or repair those errors and (2) to automatically repeat previous phonemes and words.

Personal Standards scores would be likely (1) to adopt a lower speech rate; (2) to achieve a lower error rate; and (3) to have either an unchanged or a slightly higher disfluency rate.

In the next two conditions (2a & 2b) participants were instructed to speak as quickly as possible. One of these two conditions involved auditory masking, the other was unmasked. We predicted that, in the *un*masked condition, compared to participants with "normal" FMPS profiles, participants with FMPS subscale profiles similar to those of people who stutter would be likely (1) to adopt a lower maximum speech rate; (2) to make fewer errors; and (3) to be more disfluent. These differences would be due to their more cautious approach to speaking. However, in the masked condition, because participants are less aware of their errors, their FMPS scores should not predict their performances (see below for a detailed explanation of the predictions relating to masking).

The final condition (condition 3), was a fixed (fast) speech-rate condition. Participants were instructed to start a new word each time they saw to a visually presented metronome beat and also instructed *"just pay attention to speaking in time to the visual signal and don't worry about your mistakes"* This condition involved auditory masking throughout, the intention being that the combination of (1) the instruction not to worry about mistakes; (2) speaking under conditions of auditory masking; and (3) the need to pay attention to a visual signal while speaking, would suffice to maximally distract participants' attention away from their speech and reduce monitoring and their awareness of their errors to a minimum. We thus predicted that, in this condition, disfluencies and error repairs would be reduced to a minimum (and perhaps even entirely disappear) and that participants' error-rates would thus reflect their underlying levels of language production ability and articulatory skill, free from the effects of any tendencies to engage in error repair or avoidance activity, and therefore also free from any influence of perfectionism. We therefore predicted that, in this condition, participants' speech performance would not be in any way related to their FMPS profile.

This final condition also provided a test of whether participants, irrespective of their articulatory ability and FMPS ratings, had the potential ability to *not* pay attention to errors and to *not* engage in error avoidance or repair activity, and whether they all had the ability, under such circumstances, to speak fluently and quickly.

Auditory masking

To test the hypothesis relating perfectionism to hyper-vigilant monitoring it was necessary to find a way of manipulating the extent to which participants monitor their speech. In previous research, two methods have been used successfully: (1) *dual tasks* - in which the secondary task effectively distracts the speaker's attention away from his speech (e.g. Arends, Povel & Kolk, 1988; Oomen & Postma, 2001 & 2002; Vasić & Wijnen, 2005); and (2) *auditory masking* - which actively prevents speakers monitoring auditory feedback (e.g.Postma & Kolk 1992; Postma & Noordanus, 1996; Wingate, 1970). Both methods have advantages and disadvantages. Dual-tasks increase the speakers' overall cognitive burdens and thus slow their rate of language production, possibly leading to automatic phoneme and word repetitions (Oomen & Postma, 2001 & 2002; Vasić and Wijnen, 2005). They also necessitate more complicated experimental designs and it can be difficult to pitch the secondary task at a level that ensures that both tasks really are performed simultaneously. Their effects can therefore be somewhat variable. Auditory masking, on the other hand, appears to reduce the overall cognitive burden leading to lower error rates if speech-rate is held constant (Postma & Kolk, 1992). Compared to dual-tasks, the effect of auditory masking is relatively consistent. Specifically it leads to substantial reductions in disfluencies both in stutterers (see Wingate, 1970 for a review) as well as in non-stutterers (Oomen Postma & Kolk, 2001; Postma & Kolk 1992; Postma & Noordanus, 1996), despite the fact that it does not prevent monitoring of inner-speech or of tactile and proprioceptive feedback. For practical reasons, and because of its consistency, we thus decided to use auditory masking to manipulate monitoring vigilance.

Specifically, we predicted that the fluency-enhancing effect of masking should be greatest in participants who would normally tend to monitor their speech most vigilantly. Thus, if the FMPS profile associated with stuttering and higher Fluency Difficulty scores is associated with more vigilant monitoring, the fluency-enhancing effect of auditory masking should be greatest in experiment participants with that FMPS profile.

Materials

Previous studies of disfluency have involved the analysis of spontaneous speech, reading and repetition as sources of speech samples. Each of these approaches has its own advantages and disadvantages. For example, spontaneous speech is likely to contain the widest variety of disfluencies, including those stemming from conceptualization and word-finding difficulties and also appropriacy repairs (Levelt, 1989); whereas reading or reciting from memory generally result in a much narrower range of disfluency types, but have the advantage of affording direct comparisons between participants thus enabling meaningful results to be elicited from smaller speech samples.

As we were primarily interested in “stuttering-like” disfluencies, which have been equated with slow or impaired phonological encoding (Postma and Kolk, 1993; Howell & auYeung, 2002) we decided that tongue-twister repetition would provide the most suitable source of speech samples. Our decision was guided in particular by Wilshire’s (1999) study, which found tongue-twister repetition to be an effective way of eliciting substantial numbers of phonological errors, as well as by earlier studies which have successfully used tongue-twisters to compare maximum speech rates attained by stutterers and non-stutterers (Postma, Kolk, & Povel, 1990) and to examine the effect of auditory masking and accuracy requirements on the speech-quality of non-stutterers (Postma & Kolk, 1992).

Order of conditions

Practical considerations dictated that each participant completed the experimental procedure in a single session. Thus, to maximise the likelihood that the speech-rates adopted by participants in response to the instruction to “speak at a rate that feels comfortable to you” reflected their normal choice of speech rate, this was always the first condition of the session. The two maximum speech rate conditions (with and without auditory masking) were counterbalanced with each other. The fixed-speech-rate, no-repair condition was always presented last, thus ensuring that the instruction not to attend to errors only influenced participants’ choice of speaking strategy in that particular condition.

Method

Participants

After obtaining ethical approval, 25 male and 25 female native English-speaking students, mostly undergraduates (from a variety of faculties), were recruited through

Edinburgh university's "Subject pool" facility. Each was paid £6. Their mean age was 22.02 (s.d. 2.70).

Materials

The same 9 tongue-twisters (see appendix 1 for details) were used, in the same order, in all experimental conditions. They were selected from those used in a study of language production by Dell, Burger and Svec (1997). Each was composed of four words that constituted a semantically coherent phrase, e.g. *Brad's burned bran buns*, which rendered them relatively easy to memorise and repeat from memory. Piloting ensured that all tongue-twisters caused frequent phonological errors, and that they varied in the extent to which they caused articulatory difficulty, thus minimizing the possibility of ceiling and floor effects.

Auditory masking was achieved using "pink-noise", which is perceptually similar to white noise but less harsh, due to its intensity reducing at approximately 3dB per octave, with lower frequencies thus having greater power.

Procedure

Before beginning the session, participants were instructed to read an introductory script which explained that the study was investigating the relationship between speech and attitudes and beliefs and that it included a 20 minute experiment that involved tongue-twister repetition followed by a 10 minute "beliefs and attitudes questionnaire". Perfectionism was not mentioned. Participants were then seated in a quiet experimental booth in front of a 17 inch computer monitor. To the side of the monitor were a set of headphones. They were then informed that some parts of the experiment involve noise to prevent them hearing the sound of their own voice, and were instructed to adjust the noise loudness in advance by putting on the headphones and gradually turn up the volume, while repeating "one two three" out loud, until the noise was loud enough to prevent them hearing hear the sound of their voice. The experimenter checked to ensure the masking was adequate. Participants were then requested to remove the headphones and only to put them back on as and when instructed. The experimenter then left the booth.

Instructions then appeared on the monitor informing participants (1) that a tongue-twister would be displayed for 7 seconds (2) they should memorise it while it is visible (3) when it disappears they should start repeating it out loud, over and over, *at a rate that feels comfortable* until instructed to stop. Participants were then instructed to press ENTER to start a trial run of the first condition.

The tongue-twister to memorise was displayed in black 32 point Comic Sans script on a grey background. For the final 3 seconds of the display a 3-2-1 countdown signal was also visible, following which the tongue-twister disappeared and was replaced by a blank green screen. While the green screen was visible participants repeated the memorised tongue-twister over and over, without stopping until, after 9 seconds, it was replaced by a red screen with STOP written in the middle of it. The red STOP screen remained visible for 2 seconds, following which, a screen appeared instructing participants to call for help if they were still unsure what to do or otherwise to press ENTER on the keyboard to continue on. If they opted to press ENTER to continue a (grey) screen displaying the next tongue-twister to be memorised appeared. This procedure was repeated 9 times (1 practice run and 8 experimental runs).

As soon as the final tongue-twister of condition 1 was finished, instructions for condition 2 appeared on the screen.

There were two versions of Condition 2 each containing all nine tongue-twisters. One version involved auditory masking (participants were instructed to wear the headphones) and the other did not. All participants completed both versions, the order of which was counterbalanced between them. For both versions the procedure was identical to Condition 1 except that participants were instructed to *"speak as fast as possible"* and to put on the headphones for the version with auditory masking. The masking noise was timed to start and stop with each onset and offset of the green screen.

As soon as the two versions of condition 2 were completed, instructions appeared on the monitor screen for condition 3.

At the start of Condition 3 the on-screen instructions informed participants that when the screen turned green, in the middle of it, they would see a series of dashes, the number of which would change every 400ms. Participants were instructed to start a new word every time the number of dashes changed. The dashes thus acted like a visually presented metronome. Before beginning this condition, participants were also instructed "Don't worry if you make some mistakes, just focus on keeping time with the visual signal" Condition 3 was carried out entirely under auditory masking conditions. Again, there was one trial session followed by the same 8 tongue-twisters as in the previous experiments. The tongue-twister to be memorised was presented in the same way, except the countdown at the end of the display went from 4 to 1 at 400ms intervals, thus providing participants with a prior indication of the speed that the metronome would beat at. The experimenter observed the trial session to ensure the participants had understood and were following the instructions.

Once the participant had completed the last tongue-twister, the experimenter set up the online questionnaire on the screen for him/her to complete. The questionnaire was identical to the one completed by the non-stuttering controls in the online survey.

Coding and analysis

Coding and analyses of the speech samples from all four conditions were carried out in the same way. Each utterance to be analysed lasted for approximately 9 seconds (corresponding to the length of time the green screen was displayed on the monitor) and contained multiple repetitions of a single tongue-twister. For each tongue-twister and in each condition, the number of repetitions successfully completed by at least 80% of participants within the allotted 9 second window was chosen as the number of repetitions that would be analysed. As a result only the first 3 to 5 iterations of each tongue-twister were selected for analysis (for example, in condition 1, only 3 repetitions of "Brad's burned bran buns" were analysed, whereas in the fixed-rate condition the number analysed was always 5)[10].

Using Praat software (Boersma & Weenink, 2008). A spectrographic image of each (9 second long) tongue-twister utterance was produced enabling accurate measurement of the time from the onset of its first iteration to the offset of the last iteration to be analysed (i.e. iteration 3, 4 or 5). Data were entered into an Excel spreadsheet, which enabled the total (ideal) number of syllables contained in the analysed iterations (and thus also the syllable-rate) to be calculated automatically[11]. The total number of disfluent syllables present in the analysed portion of each 9

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[10] Restricting the number of repetitions coded helped minimise confounding due to increased practice effects in participants who spoke faster and thus completed more repetitions.

[11] Automatic calculation of the syllable rate was chosen for practical reasons. It should be noted that in cases where the speaker's disfluencies resulted in syllables or words being repeated this "ideal" syllable-rate measure may sometimes have been lower than the actual syllable rate.

second sample was also counted, thus enabling the total number of fluent syllables to be calculated.

A syllable was considered disfluent if it was repeated or substituted, contained a prolongation, or was preceded by a silent or filled pause. Disfluencies involving single repetitions of word-strings, words or part-words were coded as a single disfluency. A maximum of one disfluency and/or error and/or repair per syllable was coded (no disfluencies involving multiple repetitions occurred). Pauses and prolongations were only counted as disfluencies if they were abnormal insofar as they were perceptibly longer than in the speaker's other iterations of the same tongue-twister. Generally speaking the first iteration of each tongue-twister in each condition was the most fluent and error-free, and thus could be used as a yard-stick for the remaining iterations.

A similar counting procedure was also adopted with respect to errors and error-repairs. Errors involving transpositions were counted as single errors. Phoneme omissions were only counted as errors if the speaker normally included those phonemes in the particular word in which they occurred. Each error-repair was coded as 1 error, 1 repair, and 1disfluency.

Although disfluencies, errors, and error-repairs were further sub-categorised into types, the sub-categories were not used in the statistical analysis and details are not given here. A speech therapist was employed to double-check the coding of five randomly selected participants. Inter-rater reliability on these samples was 79% for errors, 92% for repairs and 82% for disfluencies.

Analysis

Mixed effects modelling was used to test the experimental predictions, thus enabling the random variance between tongue-twisters as well as that stemming from the differences between participants to be accounted for within the same model. Separate models were constructed for each of the following four dependent variables: (1) speech rate, (2) disfluency likelihood[12], (3) error likelihood, (4) error-repair likelihood[13]. Speech-rate was assessed using linear mixed effects modelling, and

[12] Disfluency likelihood is defined as the ratio: total disfluent syllables/total fluent syllables

[13] Error-repair likelihood was defined as the number of errors repaired divided by the number of unrepaired errors.

logistic mixed effects modelling was used to assess disfluency-likelihood, error-likelihood, and repair-likelihood (following Jaeger, in Press).

Fitting was achieved using the *languageR* (Baayen, 2008) and *lme4* library (Bates, Maechler, & Dai, 2008) in the R statistical package (R Development Core Team, 2008). Both linear and logistic models were fitted in a stepwise manner, in which predictors were added, one at a time, to the null model (which contained only an intercept). The predictive power of each model was gauged by its log-likelihood statistic. This statistic is a measure of the amount of unaccounted-for variance that remains, and is analogous to the residual sum of squares in multiple regressions (Field, 2005). Improvement in a model (as measured by the reduction in its log-likelihood ratio) as a result of adding an extra predictor was assessed with ANOVA tests. For the linear mixed effects modelling of speech-rate, the *p*-values were derived from 10,000 Markov Chain Monte Carlo (MCMC) samples (p_{mc}) as recommended by Bates, Maechler, & Dai (2008).

The random variables included in the four models were *participant* and *tongue-twister*. The fixed predictor variables, chosen on the basis of their having predicted Fluency Difficulty in the respondents who stutter in the online survey, were (1) Concern over Mistakes (CM) and (2) Personal Standards (PS). For all experimental conditions, we evaluated whether CM and PS, either alone or in combination improved the model fit when entered stepwise into a null model with just an intercept.

The two maximum speech-rate conditions were analysed together, therefore, for these conditions, two additional variables were also evaluated: one reflecting presence or absence of masking, the other reflecting order (i.e. condition 2.1 or 2.2). As these were counterbalanced, for half of the participants 2.1 was masked and, for the other half, 2.2 was masked.

In these maximum speech-rate conditions, the prediction that the size of the (fluency-enhancing) masking effect would be modulated by participants' FMPS profiles was tested by adding the Masking*CM and Masking*PS interactions as additional predictors.

Results

The data from two students were excluded from the analysis because the biographical section of their questionnaires revealed that one had a stutter and the other had a mild form of apraxia of speech that caused difficulties with word-order.

Condition 1

In Condition 1, in which participants were instructed to speak at a rate that feels comfortable, a total of 7654 syllables uttered by (the remaining) 48 participants were analysed. Of these, 4.19% contained errors and 5.70% were disfluent. Participants' average syllable-rate was 2.75 syllables/second (s.d. 0.84). As anticipated, participants appeared to be using a variety of speaking strategies – some speaking slowly and carefully, with few errors and disfluencies, and others speaking at a faster rate and making more errors. Overall, participants repaired 61.9% (s.d. 30.1) of the errors that they made. (See Appendix 2 for full details)

Despite the considerable differences between participants' performances, the mixed effects analyses showed that, with respect to syllable-rate, error, error-repair and disfluency likelihood ratios, neither the CM nor the PS FMPS predictors reduced the log-likelihoods significantly below the null (intercept only) models (in all cases p>.10). (See table 5 for details of the saturated models)

Table 5. Tongue-twister Condition 1. Saturated mixed effects models of syllable rate, error likelihood, disfluency likelihood, and error-repair likelihood; showing significant predictors.

	Fixed effect	Coefficient estimate	SE	Log likelihood	*Wald Z (t)*	*P (p MCMC)*
Syllable rate	Intercept	2.734	0.223	-331.0	(12.26)	(< 0.001)
Errors	Intercept	-3.2464	0.1598	-230.7	-20.31	< 0.001
Disfluencies	Intercept	-2.9264	0.1884	-252.3	-15.54	<0.001
Repairs	Intercept	0.4985	0.2014	-144.3	2.475	0.013

Condition 2.1 and 2.2

In the two maximum speech-rate conditions, from the 48 participants a total 20,083 syllables were analysed of which 7.15% contained errors and 4.46% were disfluent. Participants' overall average syllable-rate was 3.8 syllables/second (s.d. 1.06). (See Appendix 2 for full details).

Estimation of linear mixed effects resulted in a saturated model for (log-transformed) syllable rate in which intercept, order and masking were all significant predictors. Both masking (unmasked or masked) and order (first or second block) were positively correlated to syllable rate, order more so than masking, the coefficients being 0.3041 (t = 8.451, p_{mc} <.001) and 0.0739 (t= 2.055 p_{mc} = .0501) respectively. Interaction effects were not significant. Adding CM, PS and the CM*Masking and PS*Masking interaction as predictors also did not significantly improve the model fit (in all cases, χ^2 <1, *p*>.10).

Error likelihood ratios remained unaffected by all predictors, the only predictor that came close to producing a significant improvement to the model fit being masking (log likelihood -527.69, χ^2 = 2.4227, *p*>.10) .

Disfluency and error-repair likelihood ratios both decreased significantly with masking and with the second block, resulting in a saturated model that contained both order and masking as predictors (see table 8 below). Again, adding the CM and PS FMPS sub-scale ratings as predictors did not lead to a significant improvement in the fit of these models (for both CM and PS, χ^2 <1, *p*>.10). Adding CM, PS and the CM*Masking and PS*Masking interaction as predictors also did not significantly improve the model fits, the only model that came close to an improvement being the addition of CM and PS together with the CM*Masking interaction, with disfluencies likelihood as the dependent variable (log likelihood -507.88 χ^2 = 5.6059, *p*>.10). See table 6 for a summary of saturated models for Condition 2.

Table 6. Tongue-twister Conditions 2.1 & 2.2. Saturated mixed effects models of syllable rate, error likelihood, disfluency likelihood, and error-repair likelihood; showing significant predictors.

	Fixed effect	Coefficient estimate	SE	Log likelihood	*Wald Z (t)*	*p* (*p MCMC*)
Syllable rate	Intercept	0.3040	0.2915	-642.50	(11.336)	(<0.001)
	order	0.3041	0.0360		(8.451)	(<0.001)
	masking	0.0739	0.0360		(2.055)	(0.051)
Errors	Intercept	-2.6903	0.25426	-528.9	-10.81	<0.001
Disfluencies	Intercept	-2.36915	0.27852	-510.7	-8.506	<0.001
	order	-0.41342	0.07305		-5.659	<0.001
	masking	-0.61340	0.07216		-8.501	<0.001
Error-repairs	Intercept	0.5781	0.3921	-369.4	1.474	0.763
	order	-0.4716	0.1397		--3.376	<0.001
	masking	-1.4649	0.1414		-10.356	<0.001

Condition 3

In this final, fixed-speech-rate condition, from the 48 participants, a total 10,992 syllables were analysed of which 4.75% contained errors and 0.48% (i.e. a total of 53 instances) were disfluent; although overall, 4.79% of the errors were repaired (the total number of repairs being 25). 33 participants did not repair their errors at all. All participants adhered closely to the speech-rate indicated by the 400ms "beats" of the visual signal, the mean speech-rate being 0.405 words/second (s.d. 0.03).[14]
(For full details see Appendix 2)

Stepwise estimation of logistic mixed effects was only carried out with error likelihood as the dependent variable. This resulted in a saturated model for syllable rate in which only the intercept was a significant predictor (see Table 7). Adding FMPS sub-scale ratings as predictors did not lead to a significant improvement in the fit of these models (for both CM and PS, $\chi^2 < 1$, $p > .10$).

Table 7. Tongue-twister Condition 3. Saturated mixed effects model of error likelihood, showing significant predictors.

	Fixed effect	Coefficient estimate	SE	Log likelihood	*Wald Z*	*P*
Errors	Intercept	-3.2622	0.2785	-326.8	-11.71	< 0.001

Discussion

Condition 1: "speak at a rate that feels comfortable"

In condition 1, overall, participants spoke more slowly, made fewer errors , and repaired more of the errors that were made (59.5%) than in any other condition. This suggests that, as a group, they were motivated to maintain a relatively high standard of accuracy despite the lack of any real need to do so.

Although the experimental participants' mean Concern over Mistakes and Personal Standards FMPS subscale self-ratings differed from those of the respondents

[14] The syllable rate was more variable because tongue-twisters contained a mixture of mono- and bi-syllabic words. (3.63 syll/sec. s.d. 0.73).

who stutter in the online survey, the ranges were of similar magnitude (See Appendices 3 & 5). Participants' speech- rates, error, error-repair, and disfluency-rates in Condition 1 of the experiment were also spread over a relatively wide range of values, suggesting that this experimental condition had the potential to reveal the predicted correlations between FMPS subscale ratings and the above 4 dependent measures if such correlations existed. Yet despite this potential, no correlations with *p* values that even approached significant levels were found.

There may be a number of reasons for these null results. One is that such correlations do exist but because of the confounding influence of other uncontrolled variables the experimental procedure did not reveal them. In this regard, feedback from a number of participants suggested that differences in their abilities to remember the tongue-twisters may have confounded the results to a certain extent, and the results of condition 3 of the experiment (the fixed speech-rate condition) suggested that the wide range of participants' underlying articulatory abilities may also have acted as a further confounding factor. So this is certainly a possibility that cannot be ruled out.

An alternative explanation for the null results in condition 1 is that the participants' speaking strategies and related error and disfluency rates were not related to their underlying attitudes and beliefs as measured by the CM and PS FMPS subscales and, thus, their levels of concern over mistakes and personal standards did not influence their choice of speech-rate or the vigilance with which they attended to their speech errors. If this alternative explanation is the correct one, then, to the extent that the disfluencies of stutterers and of non-stutterers stem from the same underlying mechanisms, these findings suggest that the FMPS subscale responses that were provided by the respondents who stutter (in the earlier, online survey) were likely to have reflected their perfectionistic attitudes specifically towards speech, rather than towards actions in general. At least, this would provide a parsimonious explanation of why correlations between FMPS and Fluency Difficulty ratings were found in the responses of respondents who stutter whereas the equivalent correlations were not found between the tongue-twister participants' responses. A less parsimonious explanation, which nevertheless cannot be entirely ruled out, is that is that stuttered and normal disfluencies do not stem from the same underlying mechanisms.

Conditions 2.1 & 2.2 "speak as fast as you can"

The results from Conditions 2.1 & 2.2 show that the experimental procedure was sensitive enough to detect changes in speech rate, disfluency, and error-repair rates that resulted from order (i.e. 2.1 versus 2.2) and from the imposition of auditory masking. Specifically masking and order both led to significantly reduced disfluency rates and repair rates and significantly increased speech rates. [15]

A second important finding from experimental conditions 2.1 & 2.2 was that under conditions of auditory masking, although participants' disfluency and repair rates decreased and speech rates increased, their error rates remained relatively stable. To the extent that auditory masking reduces the vigilance with which speakers are able to monitor their speech, these findings imply that, as a group, the tongue-twister experiment participants were more vigilant in their monitoring than they needed to be and that this hyper-vigilance was disruptive insofar as it slowed them down and made them more disfluent.

These findings which are similar to those attained by Postma and Kolk (1992) in a similar masking study, can be explained in two ways: (1) masking frees up cognitive resources that would normally have been dedicated to monitoring thus enabling an improvement in the accuracy/speed of language encoding, (as suggested by Oomen & Postma; 2002); or (2) masking reduces that level at which the release-threshold for words stored in the articulatory buffer is set. This second explanation, which is in line with Howell's (2003) extension of the EXPLAN hypothesis, suggests that, in speakers generally, the buffer release threshold is set at a somewhat higher level than is necessary, thus a reduction in disfluency rates can occur without causing a corresponding rise in error rates.

The third important finding of conditions 2.1 & 2.2 was that participants' FMPS scores did not predict the maximum speech rates they achieved, nor did they predict their error, repair or disfluency rates. This finding, which is similar to that of condition 1, adds further weight to the hypothesis that participants' levels of concern over mistakes and personal standards with respect to performing actions generally does not affect their speaking strategies. Furthermore, adding the two-way interactions Masking*CM and Masking*PS as extra predictors did not improve the

[15] With respect to order, the second block of tongue twisters were spoken significantly faster and more fluently than the first block.

predictive power of any of the 4 models, thus suggesting that participants' levels of concern over mistakes and personal standards do not influence the vigilance with which they monitor their speech. Thus, despite providing evidence that participants overall benefit from monitoring their speech less (insofar as less monitoring leads to a lower disfluency rate without any loss of accuracy), there was no evidence to suggest that the perfectionists amongst them benefitted any more (or were any more hyper-vigilant) than the non-perfectionists.

It was noticed that the loudness with which participants spoke increased under masking conditions. This "Lombard reflex" (Lane & Tranel, 1971) was, however, quite variable between participants and, in those participants where the effect was most pronounced, it appears likely to have limited their abilities to speak at a fast rate. This may partially explain why, despite speaking significantly more fluently and making fewer repairs, the increase in participants' speech rates was only marginally significant under auditory masking conditions. Postma and Kolk (1992) reported similar findings and further suggested that the increased effort put into articulation due to the Lombard effect may also result in a decrease in errors and disfluencies. It thus seems likely that, in both of these respects, the Lombard effect represented a potentially substantial confound that had not been anticipated or recognised during the piloting of the study.

Condition 3: "Speak in time to the visual signal"

The analysis of the results from tongue-twister Condition 3, in which participants were asked to start each new word of the tongue twisters in time to a visual metronome signal (set to "beat" at 400ms intervals) and not to worry about making mistakes demonstrated that: (1) participants exhibited a relatively wide range of articulatory abilities (as evidenced by the range of error-rates); (2) that all were capable of speaking at a fast rate with minimal or even zero disfluencies; and that (3) participants had the ability not to engage in error-repairs irrespective of how high their error-rates were.

Although it is unclear whether the lack of disfluencies and error-repairs in this condition was a direct consequence of participants having received the explicit instruction *"don't worry about making mistakes, just pay attention to speaking in time to the signal"*, or an indirect consequence of their attention having been distracted away from their speech-errors by the need to focus on the visual signals on the computer screen; either way, the results suggest that, provided speakers know exactly what words they want to utter, they have a large capacity to control whether or not they allow disfluencies and error-repairs to occur. The results of experiment 3 are thus supportive of Levelt's (1989) speech production model in which error monitoring involves perception (i.e. it is not unconscious and automatic) and is modulated by attention. Furthermore, the results also support Motley, Camden & Baars' (1982) finding that the focus of monitoring and the extent to which error-repair activity is carried out, can vary according to the perceived priorities of the situation.

As in the previous two conditions, there was no correlation between participants' FMPS subscale self-ratings and their error rates, although because Condition 3 was conducted entirely under conditions of auditory masking, such a correlation had not been predicted.

In summary, overall, the conditions of the tongue-twister experiment failed to provide any evidence that the patterns of FMPS subscale scores that were predictive of stuttering or Fluency Difficulty ratings in the online survey were also predictive of speech rates error rates, error-repair rates, or disfluency rates in the group of (normally fluent) students; nor were they predictive of monitoring vigilance. However, on the basis of the results of these experiments alone, it is not possible to choose, with any certainty, between the possible explanations (that have been discussed above) for this null result.

General Discussion

This study investigated two questions: (1) Is the presence of domain-general perfectionistic attitudes and beliefs associated with a raised likelihood of stuttering and of difficulty speaking fluently? and (2) if so, is speech-monitoring a central part of the mechanism involved in the association.

The results of the online survey that we conducted established that people who stutter do rate themselves differently to controls on two dimensions of domain-general perfectionism: Concern over Mistakes and Personal Standards. However, because the context in which the respondents who stutter completed the survey may have led them to associate the perfectionism questions specifically with stuttering and speech quality (and because of a natural tendency of people generally to relate their responses to whatever issues are of central importance to them) it was not possible to ascertain whether the ratings given by the respondents who stutter truly reflected *domain-general* perfectionistic attitudes and beliefs that they held or whether they reflected specific attitudes and beliefs in relation to their speech.

The second (experimental) part of the study sought to clarify this issue by investigating whether these same perfectionism ratings were associated with increased levels of disfluency in people who do not stutter. It also sought to clarify whether the relationship between perfectionism and disfluency is mediated by speech-monitoring. Participants' disfluency, error, error-repair, and speech-rates were measured while reciting tongue-twisters, and auditory masking was used to manipulate the vigilance of speech monitoring. The experimental study failed to reveal any significant correlations between participants' perfectionism ratings and their disfluency rates, error rates, error-repair rates or speech-rates in either their unmasked or masked speech. However, it did reveal that, in the group as a whole, the imposition of auditory masking led to decreased disfluency and error-repair rates and increased speech-rates without any corresponding increase in error-rates. These findings suggested that, in both perfectionists and non-perfectionists, less vigilant monitoring leads to an overall improvement in the quality of speech; the only disadvantage being that it reduced participants' abilities to judge whether their utterances were appropriately loud.

There are a number of possible explanations why the FMPS subscale self-ratings predicted Fluency Difficulty self-ratings in the online survey of people who stutter but not disfluency rates in the tongue-twister experiment. The first, and perhaps least likely, explanation is that the differences between the two sets of result reflect the fact that correlations between (domain-general) perfectionism and disfluency exist only in people who stutter. This would suggest that the mechanisms behind stuttering are fundamentally different from those behind normal disfluencies. A second possible explanation is that correlations between (domain-general) perfectionism and disfluency exist both in people who stutter and in non-stutterers but, because of the large number of confounding factors, the experimental paradigm used with the non-stutterers was not powerful enough to detect it. Although this is certainly a possibility that cannot be ruled out, if this were indeed the case, we would have expected to have found at least some correlations in the experimental conditions (between FMPS predictors and dependent variables) in the predicted directions with *p* values approaching significance, however this was not the case.

A third possibility, which we consider most likely when all factors are taken into account, is that the differences between the findings of the online survey and the findings of the tongue-twister experiment reflect the fact that the online survey respondents who stutter answered the FMPS questions specifically in relation to stuttering and speech, whereas the (non-stuttering) tongue-twister participants answered them in relation to their actions in general. This would, of course, also suggest that the findings of the Amster (1995) survey also reflected domain specific perfectionistic attitudes and beliefs (i.e. relating specifically to stuttering and speech quality).

With respect to question (2) above, regarding the role of speech monitoring, the findings from the comparison of masked and unmasked speech in the experimental part of the study suggest that there is not a link between (domain general) perfectionism and the vigilance with which speakers monitor their speech, although again, it would be unwise to draw any firm conclusions from the null results. The experiment did, however, reveal that the imposition of auditory masking improved the quality of speech of the group as a whole. This suggests that, irrespective of whether or not they are perfectionists, speakers may nevertheless benefit from less vigilant monitoring. Similar findings from auditory masking and dual-task studies on people who stutter (e.g. Postma & Kolk, 1990; Vasić & Wijnen, 2005) suggest that people who stutter may also benefit to a similar extent.

This general, fluency-enhancing effect of masking can be explained by Vasić & Wijnen's (2005) suggestion that freeing up the cognitive resources (that would otherwise have been engaged in speech-monitoring) allows more resources to be dedicated to language encoding, which may then become less error-prone and proceed at a faster rate. It is also in line with Howell's (2003) hypothesis that relates speakers' awareness of the adequacy of their speech (with respect its accuracy and the specific needs of the situation) to the level at which the articulatory buffer release threshold is set. It seems likely that the only disadvantage of reduced monitoring is its negative impact on the ability to appropriately regulate speech loudness.

Our measured conclusion, that the FMPS subscale ratings provided by respondents who stutter in the online survey were domain-specific (insofar as they related specifically to speech), implies that, as a group, people who stutter most probably have normal domain-general personal standards and concerns over mistakes, however, they believe that their personal speaking standards are, if anything, slightly low, and they have high levels of concern over their speech-errors.

Although the results of regression (i.e. correlational) analyses cannot be considered as indications of causality, these findings could easily be explained in terms of the frequent experiences of people who stutter, that the quality of their speech really does short of the standards that speaking situations require. Thus, in this respect, stutterers have good reason to be concerned about their speech "errors". The findings also fit well with the Vasić & Wijnen (2005) notion of a "vicious circle", wherein people who stutter have come to consider disfluencies themselves as errors.

The main limitations of the current study are that the null results of the experimental paradigm do not allow more definitive conclusions to be made regarding the relationship between domain-general perfectionism and disfluency, nor does the experimental part of the study provide any data relating to the relationship between domain specific perfectionism and disfluency. A parallel experimental study investigating the correlations between FMPS subscale scores and speech-rates, disfluency, error, and error-repair rates of participants who stutter may potentially resolve some of these outstanding issues.

Future studies may also benefit from designs that incorporate a way of distinguishing whether respondents are answering survey questions domain-generally or specifically in relation to an issue that is important for them. Perhaps it would be beneficial if questions such as those contained in the FMPS explicitly specified that domain general or domain specific responses are required. Asking each question twice (once in relation to actions in general and once in relation specifically to speech) may prove to be a workable solution.

Despite their limitations, the findings of the current study are potentially of interest clinically. In particular the findings from the online survey highlight the usefulness of approaching perfectionism as multi-dimensional, rather than mono-dimensional, construct; and thus, for example, enabling a distinction to be made between the pursuit of exceptionally high standards, and the concern, simply, that one may not be achieving standards similar to those of one's peers. Indeed, the pattern of FMPS subscale scores returned by respondents who stutter is difficult to equate with a "striving for flawlessness" or of a desire to be perfect and, in this respect, the label perfectionist may not be the most appropriate.

The findings of the current study also add to the growing body of experimental evidence in support of the (superficially paradoxical) idea that the overall quality of speech is likely to improve when speakers pay less attention to it. Knowledge of such evidence, and of the hypotheses that make sense out of it, may help encourage both clinicians and clients to explore therapeutic approaches that may otherwise appear too counter-intuitive to entertain.

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Appendices

Appendix 1. Tongue-twisters used in the experimental study

(in the order presented)

0 Bonnie's brown bread box (practice tongue-twister)

1. Five frantic fat frogs
2. Brad's burned bran buns
3 Chef's sooty shoe soles
4 Thirty three throbbing thumbs
5 Gloria's Greek green gloves
6 Plastic potted pansy plants
7 Simple slender silver slippers
8 Danny's dripping dish drain

Appendix 2. Participants' performances in the tongue-twister experiment

			total syllables	errors		disfluencies		repairs		speech rate	
Condition			N	N	%	N	%	N	% errors repaired	syllables / sec (words/sec)	SD
1.	"speak at a rate that feels comfortable"		7654	321	4.19	436	5.70	191	59.50	2.75	0.84
2.	"speak as fast as you can"	Total unmasked	10104	748	7.40	574	5.68	330	44.12	3.77	1.05
		Total masked	9979	688	6.89	321	3.22	134	19.48	3.83	1.07
		Total in Block 2.1	9916	713	7.19	519	5.23	271	38.01	3.65	1.20
		Total in Block 2.2	10167	723	7.11	376	3.70	193	26.69	3.95	1.07
		Grand total	20083	1436	7.15	895	4.46	464	32.31	3.80	1.06
3.	"speak in time to the visual signal" (400ms/word)		10992	522	4.75	53	0.48	25	4.79	3.63 (0.405)	0.73 0.03

N= 48

Appendix 3. Tongue twister participants' self-ratings.

	Concern over Mistakes	*Personal Standards*	*Parental Expectations*	*Parental Criticism*	*Doubts about actions*	*Organization*	OASES Difficulty communicating
Mean	21.79	24.60	13.81	7.7083	11.292	20.167	21.88
Standard Deviation	6.59	5.46	4.05	3.02	2.98	5.13	6.42
Range	27	23	16	11	12	23	26
Minimum	9	12	6	4	5	6	9
Maximum	36	35	22	15	17	29	35
Count	48	48	48	48	48	48	48

Appendix 4. Online survey: all controls' self-ratings.

	Concern over Mistakes	*Personal Standards*	*Parental Expectations*	*Parental Criticism*	*Doubts about actions*	*Organization*	OASES Difficulty communicating
Mean	21.5	24.04	13.05	7.99	11.43	20.43	22
Standard Deviation	7.48	5.50	4.22	3.41	3.54	5.36	6.36
Range	30	24	17	15	16	24	26
Minimum	9	11	5	4	4	6	9
Maximum	39	35	22	19	20	30	35
Count	82	82	82	82	82	82	82

Appendix 5. Online survey: all respondents who stutter self-ratings

	Concern over Mistakes	*Personal Standards*	*Parental Expectations*	*Parental Criticism*	*Doubts about actions*	*Organization*	OASES Difficulty communicating	*OASES-Difficulty speaking fluently*
Mean	25.95	23.44	12.49	9.765	12.21	20.73	28.41	30.98
Standard Deviation	8.13	5.05	5.10	4.60	3.83	5.167	7.32	7.75
Range	35	24	18	16	15	20	32	36
Minimum	9	11	5	4	4	10	11	9
Maximum	44	35	23	20	19	30	43	45
Count	81	81	81	81	81	81	81	81