STAMMERING AS A CONFLICT IN COGNITIVE PROCESSES

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Descriptions of stammering typically employ multifactorial models (eg. Bloodstein 2008, Ward 2006). These can be integrated by viewing the central problem as one of cognitive feedback. In particular, if stammering is the result of excessive semantic monitoring, it is possible to account at once for improved fluency via altered auditory feedback, and for psychological effects (eg. those underlying secondary stammering). The latter is done by positing a conflict between processes, or modules (Carruthers 2008, Fodor 1983), via a mechanism loosely comparable to the approach-avoidance conflict of Sheehan (1958). It's further postulated that stammering is a remnant of early language development, perhaps still in the process of being selected out of existence.

1. INTRODUCTION

People who stammer show some astonishing characteristics. One is the ability of many, midway through a severe block, to break off, add a fluent aside such as "Gosh, this is difficult", then continue stammering where they left off. You could add to this the ability of fluent speech with no audience, or when acting, and variance of severity in bilinguals (stammering is usually more severe in the second language; Van Borsel, 2001).

There is, thus, an undeniable psychological substrate to stammering. But it also varies along other axes, of which perhaps the most puzzling, in view of the psychological variance, is auditory feedback. For example, prevalence is less among the hearing impaired[1], and it's well established that changing what stammerers hear (eg. by delaying, shifting pitch of or masking auditory feedback) will reduce severity. Indeed, there are commercial, hearing-aid style products aimed at providing this capability on the move. You could also argue that the end result of many adult therapies, with the stammerer deliberately inserting tiny prolongations onto the beginnings of words, mimics the effects of delayed auditory feedback.

For reasons of theoretical parsimony, I'm proposing that the psychological and auditory effects are actually the same thing. I've done this by hypothesising excess semantic feedback in self-generated speech as the root of stammering. What I mean by

1 See Snyder (2006) for a discussion of stammering in sign language.

Note: Stammer and stutter are synonyms (Van Riper, 1982, has a lovely etymology). I've used stammer for three reasons: (1) it's standard British use; (2) I prefer to skirt the rhyming connection to the probably related (Ward 2011) cluttering; (3) I reserve the rather pleasing pun "stammer time" for future work on the moment of stammering.

this is that your own speech would have increased cognitive prominence. It would be like speaking through a megaphone, but in terms of importance not loudness. Of course, this sounds a bit like wondering if I see the colour red in the same way that you do. But, even here, there are studies suggesting, for example, that some women can see shades of red that men can't (Jameson et al, 2001). When your girlfriend says your belt doesn't match your shoes, she might really be onto something. In a similar way, it might be possible to establish the kind of difference I'm looking for.

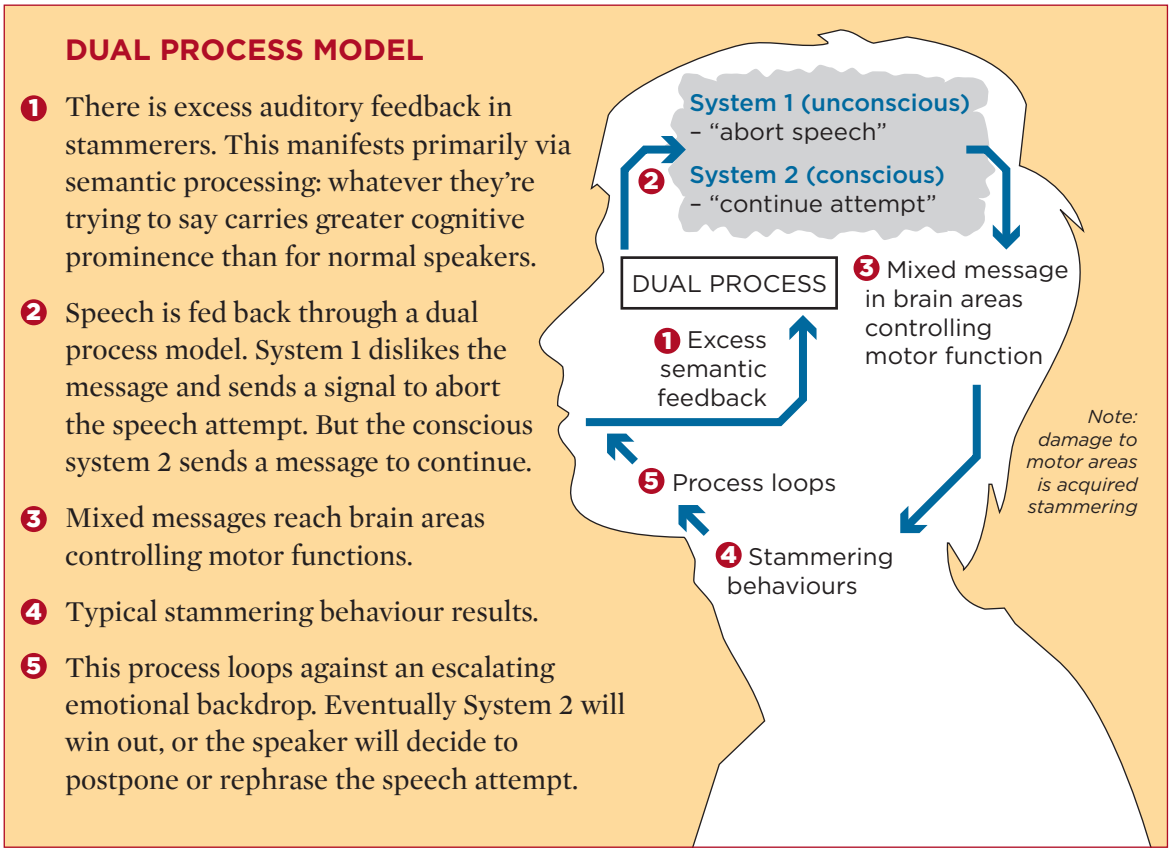
What follows is really an argument that my premise is plausible, and can be developed into worthwhile cognitive and psychological models. As such, many sections are tentative suggestions, or markers in the sand. It would have been nice to write in long form, and then précis for presentation here, but developing ideas seems to work the other way around. Doing it this way, I can at least limit the scope of enquiry early on.

1. BRIEF OVERVIEW

I think it's best if I give an overview first, and add detail as we go on. Figure 1 shows a dual process model of the kind of conflict I have in mind. Note that there are going to be other ways to draw this: it's not presented as a final model.

The essential feature is that the feedback loop involves the entire cognitive and psychological apparatus. This accounts for all the variability observed – it sometimes seems as if there are as many types of stammering as there are types of people. It also means that I'm explaining secondary stammering features (the grimaces, foot taps, avoidances and so on, all learnt behaviours) at the same time as the primary features (unforced prolongations and repetitions). As such, I'm concentrating on the adult condition. Extension to beginning stammerers is straightforward (the secondary behaviours haven't been learnt yet), but I don't, for now, address the

Figure 1: Dual process model for stammering. Compare with figure 3.



pivotal question of why there is such a high (approximately 75 per cent) natural recovery rate. This is probably due to inheritance of a vulnerability to stammering, and interaction of this with environmental factors, and as such is likely to be a story of brain plasticity. There's a bit more about this in the appendix (and scattered elsewhere), but it's really an area for follow-up work.

2. SPEECH MODELLING CONSIDERATIONS

If we didn't monitor speech semantically, we'd never understand each other. Thus, the excess semantic feedback idea isn't entirely foolish, it's just the kind of thing you'd never normally think about. It's furthermore elementary, via a variety of methods (eg. bone conductance, and whatever internal routines you suppose) to differentiate self-generated speech from the cocktail party of everyday life. But, it's not clear what form this monitoring takes, or to what degree (if any) it could vary between subjects.

Levelt (1989) offers a popular speech production model, addressing some of these concerns and providing mechanisms for error detection. But Hagoort and Levelt (2009) add that "despite general agreement about the steps that connect intention to articulation, there is no consensus about their temporal profile or the role of feedback from later steps". In fact, there's no speech production model which explains stammering[2]. Levelt's model is useful, but for semantic feedback in stammering something more will be required.

Stammering is reduced with delayed auditory feedback of typically 50–100ms, for normal speech rates (see the review by Lincoln et al, 2005). It is also effective around 250ms, but the spoken output is slowed. Interestingly, these figures are similar[3] to what you see in speech shadowing experiments, in which normal speakers repeat speech fed in through headphones. Fodor (1983) makes the point that there must be semantic processing happening with these delays. And moreover, the processing could likely go quicker but, since a syllable is the smallest identifiable component and you're limited to about four per second, the speech stream (and, he might have added, the vocal mechanism) provides an upper limit. This is backed up by studies with speeded-up speech.

Carruthers (2006) outlines a speech production mechanism with thoughts occurring in mentalese, and a language sub-system drawing on lexical, syntactic and phonological knowledge to formulate the sentence to be uttered. Something along these lines, and including modular conflict as well, might provide a complete model of stammering. I'll explore this a little more later, but note for now that follow-up work might well take this direction.

Finally, I'll propose a secondary plausibility argument. Evolution of language is contested (see, for example, the debate between Fitch, Hauser and Chomsky, 2005, and Pinker and Jackendoff, 2005). But however it came about, it's unlikely to have appeared all of a sudden in the form we see around us. There would have been some experimentation first. Variation in semantic monitoring might have been one of these. This is maladaptive, but not disastrously so: people who stammer exhibit full human variability in other areas, compensating for their handicap and leading normal lives. Covert stammerers will even present as normal speakers. Furthermore, given that when hereditary the trait can skip generations, it wouldn't even be selected away particularly quickly. This is amplified

2 It seems irresistible to extend Levelt's model in this direction, which is what Postma and Kolk (1993) do in their covert repair hypothesis. But their feedback loop appears prevocalisation, and is confined to phonology. It thus has no direct bearing on the semantic feedback model proposed here.

3 Of course, with frequency altered feedback or masking, there is no delay. But, both of these reduce stammering less effectively than delayed feedback. The difference, which might be crucial, is that delays of around 50-250ms displace the feedback such that it still arrives within its typical processing window.

when you consider that it seems to be susceptibility to, rather than certainty of, stammering that's transmitted. We may thus be in a long tail of stammering in humans, with the incidence gradually declining over millennia[4].

4. APPROACH-AVOIDANCE CONFLICT

Motivational conflict isn't a new idea. Pleasure and pain are found in the writings of Democritus, Bentham, James and Freud. But the story for us really begins with Lewin's work on approach-avoidance in the 1930s. This is a gestalt field theory, with psychological and physical objects possessing positive or negative valences, and humans operating along these vectors. The resultant conflicts are shown in table 1, opposite.

Sheehan (1953, 1958) posits stammering as a double approach-avoidance conflict:

> *[The stutterer] can speak, thus achieving his aim of communication, but at the cost of the shame and guilt he has learned to attach to his stuttering. Or he can remain silent, abandon communication, and suffer the frustration and guilt that such a retreat carries with it.*

Sheehan was influenced by the work of Miller[5] and Dollard (1950), which added the detail that avoidance gradients are steeper than those for approach. You can test this in experiments with rats, by training in a runway first with a food goal, then with electric shock, then a combination. Sheehan notes that, tantalisingly, at the intersection point for approach-avoidance, rats exhibit vacillations which resemble stammering. Figure 2, opposite, shows Sheehan's application of the model.

Table 1: **CONFLICT TYPES**
(after Lewin)

APPROACH-APPROACH: you are drawn to two attractive goals, *eg. order the lobster or the filet mignon?*

AVOIDANCE-AVOIDANCE: you are repelled by two unattractive options, *eg. work over the weekend for a Monday deadline, or submit your paper late?*

APPROACH-AVOIDANCE: you are attracted and repelled by the same goal, *eg . (for smokers): smoke a cigarette?*

DOUBLE APPROACH-AVOIDANCE: you are attracted and repelled from incompatible goals, *eg. work overtime (extra pay but you're tired of it) or dinner with in-laws (fulfils an obligation but they're tedious).*

Visiting the dentist can provide another example. You could also have complex, multiple approach-avoidance (eg. choosing a name for your child). Note that choices are often forced or time-bound. This conflict type can be very unpleasant, for example as in unplanned pregnancy.

Elliot (2006) notes that approach-avoidance motivations were sidelined in the 1970s and 80s, but are now gaining in popularity again. The rehabilitation seems to follow evolutionary considerations, with support from neurophysiological data. Literature in this field has expanded rapidly in recent years, with much of it collected up in Elliot and Covington (2001) and Elliot (2008).

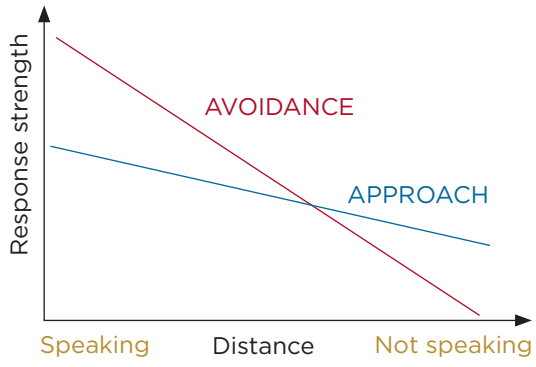


Figure 2: Approach-avoidance conflict, after Sheehan (1953). Note that relationships needn't be linear, and they often aren't in models of this type.

4 Gomez (1998) makes a related argument, that languge evolved with competition between specialisations for a language acquisition device and for theory of mind – a kind of evolutionary arms race. If he's right, the development of stammering in such an environment seems very likely.

5 To complete the historical survey: Hull developed Lewin's theory, with learning and behaviour now framed as the reduction of approach or avoidance drives. Miller was a student of Hull.

5. DUAL PROCESS CONFLICT

We introduced this idea earlier (see figure 1) but can now go add a little more detail. Dual process theories abound (for example Sloman, 1996; Stanovich and West, 2000; Kahneman, 2011), with typical characteristics as shown below.

Table 2: **DUAL SYSTEM FEATURES**
(as per Carruthers, 2008)

SYSTEM ONE	SYSTEM TWO
• A set of systems	• A single system
• Fast	• Slow
• Parallel	• Serial
• Unconscious	• Conscious
• Not easily altered	• Malleable
• Universal amongst humans	• Variable (by culture and by individual
• Mostly shared with other animals	• Uniquely human
• Impervious to verbal instruction	• Responsive to verbal instruction
• Independent of normative beliefs	• Influenced by normative beliefs
• Heuristic based	• Can involve the application of valid rules

System 1 would also contain aspects of the psychological unconscious such as implicit memory, learning and perception. This kind of activity is demonstrated by, for example, studies in semantic priming and blindsight. Kihlstrom (eg. 1996, 2007) has several useful reviews in this area.

The proposal, then, is that excess semantic feedback in stammerers[6] floods these implicit systems such that, following crude associative determination, they detect a danger and move to shut down the vocal apparatus at the same time the person is consciously sending the instruction to speak. This is a lot like the approach-avoidance conflict of the previous section, now reinterpreted along a divide in consciousness. But this isn't Freud's subconscious. As we'll see in the following sections, contemporary approaches should allow us to add a lot more detail.

6. MODULAR CONFLICT

It's also possible to frame the conflict in modular terms, after Fodor (1983). This approach can tie into dual process theory, with encapsulated, Fodor-like modules (such as vision and language) in System 1, and consciousness in a non-modular System 2. Carruthers (2008) defends an idea of weaker modules pervading both systems. We'll discuss just System 1 modules and avoid, for now, comment about how Fodor-like they must be.

Sperber and Wilson (2002) postulate a theory of mind sub-module dedicated to comprehension, with its own proprietary concepts and mechanisms. This would interact with the language processing module to generate interpretations of language, which are broadcast globally (with duration perhaps an order of magnitude shorter than working memory, as per Baars, 1997). We can suppose the same system will operate during self-generated speech. In a situation, such as I'm proposing for stammering, in which self-generated speech has excess semantic feedback (or is inadequately gated, amounting to the same thing) this could result in crude interpretations of the spoken phrase (eg. word, message or situational fears), triggering direct intervention with the speech apparatus by System 1, even as the speech attempt continues.

The resultant conflict would be rather like an attempt to cross a busy road. Indeed, behaviour on such a precipice resembles stammering, often involving a sequence of stop/start behaviour which does not feel consciously initiated. Eventually, you begin the successful crossing, or you decide to walk to a nearby bridge and so on. You could recall, in this connection, our earlier discussion of the approach-avoidance rat.

6 Conditions which could be explained similarly might include the probably related cluttering (see Ward, 2006, Ward and Scott, 2011) and possibly related Tourette's syndrome (see De Nil et al, 2004).

MODULAR CONFLICT

1. There is excess auditory feedback in stammerers, flooding semantic processing capabilities.
2. This results in modular conflict. In the diagram, theory of mind and language modules conflict (other modules may get involved, eg. facial recognition of an unreceptive audience expression) to create primary stammering. If System 2 intervenes, secondary stammering arises.
3. Mixed messages reach brain areas controlling motor functions.
4. Typical stammering behaviour results.
5. The process loops against an escalating emotional backdrop. Eventually, the speech attempt is completed (or the speaker decides to do something else).

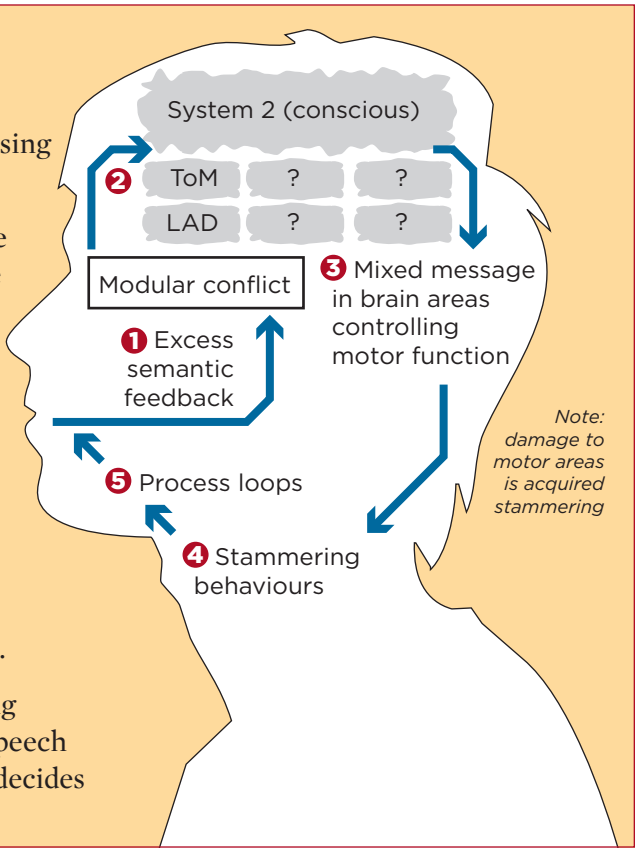


Figure 3: Modular conflict in stammering. Compare with figure 1

7. COMBINED CONFLICTS

It's possible to combine the two models just described, as in figure 3 (above). The modular conflict creates primary stammering (the unforced prolongations, repetitions etc) and the dual process conflict creates secondary stammering (jaw grimaces, avoidance behaviour and so on). This ties in nicely with adult therapy results, in that you can consciously aim to get rid of secondary stammering, essentially via conditioning techniques, but the prolongations and repetitions remain, made vanishingly small by fluency shaping or block modification therapy. So, getting rid of the primary stammering – in this view, resolving the modular conflict – might, if possible, be an ultimate therapy goal.

Alternatively, you could view the combination as in figure 1, but with modular conflict now as the cause of the System 1 disruption. This works differently, in that secondary stammering no longer sits atop primary stammering. The primary/secondary distinction isn't set in stone, so it might help to keep this possibility in mind. And I expect that further ways to frame the conflict could be conceived as well.

But, this throws up a question: are these ideas really something new, or does the combination of psychological approaches I'm suggesting merely display the fashions of yesteryear with some fancy window dressing? Development of these themes will have to explain precisely how the mechanism is supposed to work, what new claims are being made, and how these can be tested.

8. EMPIRICAL STUDIES

To search for the presence of the proposed semantic feedback, it might be nice to have people who stammer perform dual task experiments, in which both tasks are semantically demanding but only one involves speech. The prediction is that the greater load on semantic capability will

trigger increased dysfluency for stammerers compared to normal speakers. As it happens, Bosshardt (2006) has performed exactly these kind of experiments, and his results support this view.

But unfortunately, the support isn't strong. This is because Bosshardt, and many others, have found stammerers behaving differently from controls even where there's no speaking going on at all. Examples include orofacial non-speech and finger flexion movements (Borden, 1983; Max et al., 2003), finger tapping (Smits-Bandstra et al., 2006) and finger movement sequencing (Forster and Webster, 2001). Stammerers exhibit difficulty making precise movements using afferent sensory information for motor execution (De Nil and Abbs, 1991; Loucks and De Nil, 2006).

All of this suggests that stammering is really a motor problem, and indeed work in this area is well developed. Ward (2006) has a review. Here again, though, there is a problem. As noted in the introduction, motor theories can't account for the often large amount of fluent speech that all but the most severe stammerers enjoy. If it really is a motor problem, the stammering should be there all the time. There's an attempt to get around this, by defining the fluent speech of stammerers as actually stammered: apparently, there are tiny variations only measurable in laboratory conditions. This is unconvincing though, not least because the studies are on people with a history of stammering, who definitionally have abnormal speech. Furthermore, the motor theories don't account for the psychological variation (eg. from situational and emotional cues) in stammering. This could be considered as a "cognitive overload" factor, which would interfere with motor functions in times of stress, but then the question becomes one of exactly how that interface works. At this point, it's apparent that the unusual motor activity is simply a manifestation of the underlying cognitive activity. It's a truism that it's impossible to stammer without excess tension, but positing this tension as the root of the problem won't satisfy enquiring minds. Nevertheless, the motor research is useful, and the insights into brain activity, as detailed in the appendix, are valuable.

In spite of all this, the behavioural data does need explaining. It's useful here to recall the heterogeneity of the stammering population. Blood et al (2004), in a survey of 1184 clinicians and 2628 children, found 62.8 per cent with co-occurring disorders. Of these, learning disabilities (11.4%), literacy disorders (8.2%), attention deficit disorders (ADHD) (5.9%) and central auditory processing disorders (3.8%) were the most frequently reported.

I suggest that what's really happening is that, in the stammering population which presents as normal (and note here that covert stammerers will even present as normal speakers), there is actually a subtly different distribution of cognitive abilities than is observed in the overall population[7]. Discovery of an unusual distribution in a sub-population shouldn't be too surprising, and you could think of this as a kind of "lite" version of the major differences noted in Blood et al – and dependent, perhaps, on developmental history. The experience of

7 Of course, the general population can be subcategorised along myriad lines – no-one is really "normal".

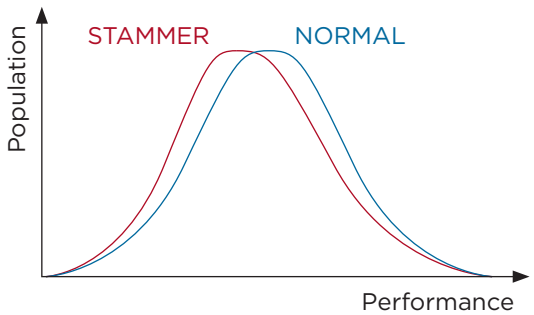


Figure 4: Suggested distribution for people who stammer on some selected, specialised cognitive tests (eg. finger tap etc). The curves needn't be this exact shape, and the difference shown is probably exaggerated. The point is a leftward (more poorly performing) shift relative to normal speakers in aggregate. Variation across tests might be possible (eg. above average at digit span, below par at finger tap, and so on).

stammering leaves scars other than just the emotional ones. Another possibility that, given the high, apparently spontaneous recovery rate in childhood, some of the triggering factors for stammering are impairments that would lead to unusual behavioural distribution. Whatever the scenario, the suggestion is that what cognitive tests are really ascertaining is the exact shape of the curves in figure 4.

People who stammer are already subcategorised along acquired and developmental lines, and it may help (both for conceptual clarity and clinical treatment, eg. in choosing between block modification and fluency shaping therapies) to extend these categorisations. Obvious receptacles for our stammerers might be things like family history and coexistence of cluttering. Work in this area would need to be done with some sensitivity – people who stammer are already isolated enough from society without being isolated from each other too.

We opened this section with a discussion of dual task experiments in stammering, and will end in the same way. Bajaj (2007) has a review which attempts to tie these with working memory[8]. A difficulty here is that the action we're interested in probably takes place in the central executive. As Baddeley (1998, 2002) keeps pointing out, the aim is to chip away at this homunculus rather than tidy more into it. And since much of action in the models described earlier will take place unconsciously, it's not even obvious how it will affect dual task experiments.

One avenue that comes to mind – and Bajaj suggests this as well – is to combine dual task experiments with variance in altered auditory feedback. I suppose it's possible, if the semantic feedback idea is correct, that you might expect to see an interface between implicit and explicit working memory (eg. as in Hassin et al, 2009) at this point. But, all of this is rather speculative – work on these themes is still developing.

8 See Barret et al (2004) for an attempt to tie working memory to dual process theories.

CONCLUSION

I've hypothesised that stammering is a result of excessive semantic feedback in self-generated speech[9], offering supporting arguments following empirical, evolutionary and theoretical parsimony considerations. The notion might be testable, and I've suggested ways of developing studies to this end.

I've then outlined several ways in which the feedback could lead to stammering, using conflict models. As an aside, there may be scope for cross pollination of dual process and modular approaches with more generalised approach-avoidance conflicts, to the benefit of both schools of thought.

The ideas presented here cover a lot of ground, and follow-up work will be required. But, there seems to be enough to suggest that research in this area will be fruitful. If stammering is anything like I've outlined, it's not only solvable but would, perhaps more importantly, provide a window into the functioning of higher level cognitive processes.

9 And if this is verified, it's possible to make a therapy recommendation: semantic reformulation may help stammerers. This is likely to be harmless even if I'm wrong – it's would amount to thinking about what you say before you say it, which isn't a bad idea for anyone.

Clinically-minded readers will have noticed that this sounds dangerously close to word substitution, the elimination of which is a major goal of early therapy. For that reason, I'd recommend that the concept only be introduced in the final stage of therapy (eg. the stabilisation phase if you're following Van Riper, 1973). People in this stage need a lot of help with their new-found fluency anyway, in no small part due to lack of experience in being able to speak freely. You simply can't build up the speaking skills that normal speakers take for granted when the act of speaking is itself so unreliable.

APPENDIX – SOME VARIABLES

NEUROSCIENCE: many studies show that stammering favours right hemisphere dominance, rather than the left hemisphere as in normal speakers. This suggests bilateral language areas in competition with each other. But the studies are on adults, raising the question of whether this is a cause or result of stammering. For example, Preibisch et al (2003), in a study of stammering adults undergoing therapy, show the right frontal operculum as the activation area, and conclude it is a compensation mechanism, ie. a result of stammering. Experiments on children would be help to settle the issue. Soo-Eun Chang is carrying out a five year longitudinal study, "Sexual dimorphism of neural development underlying childhood stuttering", with results expected in 2015.

Many brain areas have been connected to stammering. Watkins et al (2008) found that, along with a host of other unusual activity, the integrity of white matter tracts was reduced in areas of the ventral premotor cortex which are underactive during stammering. They agree with earlier conclusions that stammering viewed through an fMRI lens shows up most clearly as disruption in the cortical and subcortical neural systems connected to motor sequences in speech.

It's possible that there are distinct pathways associated with stammering. Of interest in connection to the semantic feedback idea I've proposed, Sakai et al (2009) undertook fMRI studies during delayed auditory feedback tests. They found differences in the right inferior frontal gyrus, right superior temporal gyrus, right middle temporal gyrus, and right supplementary motor area. The inferior frontal gyrus has been connected with inhibition effects, including go/no go tasks like pressing a button in response to the letters Q, P, T but not to X (Aron et al, 2004), and also with risk aversion (Christopoulos et al, 2009). Of course, it's very unlikely that cognitive function could be mapped to discrete brain parts in this area. But, if we could, it would at least fit with the ideas of conflict I've outlined.

Sakai et al also note possible effects from the scan noise of fMRI – recall that auditory masking is expected to reduce stammering. Despite an elaborate headphone/earmuff setup, they were unable to eliminate this. It's likely that the unusual experimental set up in fMRI is particularly troublesome in studies of stammering.

GENETICS: Hereditary aspects of stammering are well known, and Kang et al (2010, 2011) find the GNPTAB, GNPTG and NAGPA genes as mutated. Interestingly, the same genes are implicated in mucolipidosis, a fatal multi-organ disease. An unexpected advantage of this is that biochemical assays have been established since the early 1980s, and knock-out mice, carrying complete loss of function mutations for GNPTAB and GNPTG, have been engineered (they die at an early age after exhibiting symptoms similar to those in mucolipidosis). If knock-in mice, were created, carrying what are thought to be the human stammering mutations, their vocalisations could be studied, and they could be probed for further neurological defects or degenerative processes. This raises the prospect of stammering mice as a spectacular culmination of their efforts.

LINGUISTICS: Stammering most commonly arises in preschool children at the same time as general language development, making it difficult to separate the two. And consider here that early speech resembles stammering more than anything else. Stammering severity increases with greater linguistic demands – but, this could also be explained in motoric terms – and appears more common at the beginning of words and sentences. Stammering in adults tends to be on content words (nouns, lexical

verbs etc), whereas for children it's on function words (pronouns, prepositions etc). This latter point forms the basis of the EXPLAN model, an alternative to the covert repair hypothesis mentioned in footnote 2.

An obvious extension of the ideas in this paper would be to develop (or adapt) a linguistic model of stammering to be compatible with the hypothesised excess semantic feedback and cognitive conflict.

DEVELOPMENTAL FACTORS: Stammering most commonly arises in preschool children, with word and syllable repetitions and little sign of struggle or avoidance behaviours. A gender bias appears, with an at first small predominance favouring males (eg. 1.1:1 in Kloth et al, 1999; or 1.65:1 in Månsson, 2000, whose sample population was an entire 45,000 inhabitant Danish island) rising to the 3:1 typical of adult stammerers a few years later. Lack of variability between cultures (eg. as noted in Van Riper, 1982) implies that this is due to constitutional rather than learning factors.

A further difficulty is the apparently spontaneous recovery of some children. Stammering has a prevalence rate of about 4 per cent, and an incidence rate around 1 per cent, implying a 75 per cent natural recovery rate. This makes childhood therapy success rates difficult to judge. But, a common theme is that limiting the child's exposure to complex speech models, for example by changing family interaction styles (eg. as per Guitar, 2006), although there is debate over the exact process to follow.

Much of the thinking on childhood stammering is based around the Capacities and Demands model (Starkweather et al, 1990; see also the discussion introduced by Manning, 2000). A current development along related lines is the dual diathesis-stressor model of Walden et al (2011), which attempts to integrate emotional diathesis in the child with a speech-language diathesis (which will presumably be genetically based). This is developed following the framework of Monroe and Simons (1991), following the idea that "stress activates a diathesis, changing the potential of predisposition into the presence of psychopathology". This kind of model, with stammering varying along several axes, is likely to be necessary for an understanding of the developing condition.

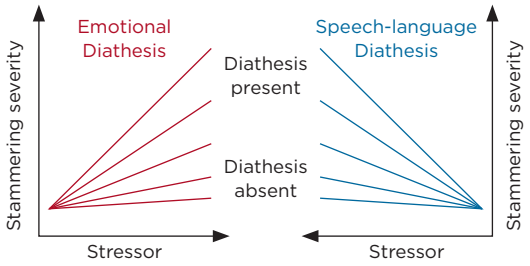


Figure 5: Diathesis-stressor model, after Walden et al (2011). This formulation allows for multiple variances in developmental stammering, tied with predisposition.

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