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Suggestions for improving the long-term effects of treatments for stuttering: A Review and synthesis of frequency-shifted feedback and operant techniques

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Abstract

The present article outlines the potential benefits to the treatment of stuttering, if altered auditory feedback methods, especially frequency-shifted feedback, were to be combined with behaviour modification techniques. A potential framework for understanding the integration of these approaches is presented in the context of assessing the limitations of each approach in isolation. A number of suggestions concerning the use of partial prompting and partial reinforcement, drawn from the animal conditioning literature, that may promote the efficacy of such a treatment are also made.

Stuttering has been targeted for treatment through the use of a wide variety of techniques, often drawn from apparently incommensurable theoretical backgrounds, or from practically-oriented approaches that appear to have little or nothing in common with each other (see Ham, 1990, for a review). Operant psychology has contributed a number of techniques to the amelioration of this speech problem. Two examples of such operant-based approaches are: habit reversal (e.g., Wagaman, Miltenberger, & Arndorfer, 1993), and response-contingent punishment (e.g., Onslow, Packman, Stocker, & van Doorn, 1997). In addition to operant-based techniques, there are a range of techniques aimed to reduce the anxiety, and/or 'self-acceptance' of the stutterer (e.g., Rustin, 1987), and a further range of interventions which apply electronically altered auditory feedback (AAF) to aid the stutterer (e.g., Howell, Sackin & Williams, 1999; Kalinowski, Armson, Mieszkowski, Stuart & Gracco, 1993). The latter form of intervention is the primary focus of the present report, in which an integration between AAF techniques and those drawn from a more traditionally operant background is suggested, both at the practical level, and in terms of a theoretical conceptualisation of the potential intervention.

Integration between these approaches is made difficult due to their quite discrepant theoretical backgrounds. As noted above, habit reversal and time-out punishment are examples of intervention for stuttering that are quite clearly behavioural in nature, the third approach is broadly 'humanistic' (but see Craig & Andrews, 1985), and the latter is underlain by a decidedly cognitive theory (see Starkweather & Gottwald, 1990). The problems facing any integrationist attempt are compounded by the fact that stuttering generally is defined topologically (i.e. by reference to the type of verbal response emitted by the subject), rather than being defined functionally, in terms of the antecedents and consequences of the behaviour (cf. Miltenberger, Fuqua, & Woods, 1998; Perkins, 1990). Little, if any, research has been conducted into the functional properties of stuttering. The focus on a topological definition promotes focus on postulated, unobserved (and possibly

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unobservable) underlying causes of stuttering behaviour. It is these putative causes that are subsequently targeted for treatment. Such causes can be regarded either as theoretically interesting entities, or as explanatory fictions, depending upon the theoretical orientation or viewpoint of the author in question. It may be that many behaviourists would object to the use of such terminology and explanations. Moreover, if such cognitive terminology is employed to describe the treatment process, then it may be that what still is being treated, in fact, is the behaviours to which such verbal labels are applied rather than the putative underlying causes. This latter point is debatable, but the fact remains that large numbers of workers do employ terms in such a way, and the fact that behavioural workers do not agree with this conception does not mean that others do not employ terms in this way.

The present article very briefly reviews a number of the behavioural intervention procedures that have been applied to stuttering, and examines their effectiveness. In the process, it is hoped to point out some issues that are germane across a number of areas of applied behaviour analysis, especially in relation to the issue of prompting. More importantly, it is hoped to present a case for an integration of AAF techniques and the interventions traditionally viewed as operant[1]. This amalgamation could provide new possibilities for clinical practice which also are briefly outlined. Of course, it is important that such an integration be performed carefully, with full appreciation of the research findings and theoretical backgrounds from both work of stuttering and stuttering therapy, since previous attempts at integration have often led to a decline in work in one or other aspects of the amalgamated procedure (see Ingham, 1993b, for a review).

The ultimate aim of the above intervention procedures for stuttering differs from approach to approach. For most, the aim is to generate fluent speech in the individual, and to ensure that this fluency is maintained beyond the confines of the therapeutic intervention. For other approaches, the important aspect of the intervention is to promote self-acceptance of the stutter in the stuttering individual. Thus, criteria regarding the successful outcome of any therapy are idiosyncratic, and depend largely upon the level of functioning which would cause a problem for the individual in their everyday life. For the present purposes, it is the former criteria that will be used as important indices of an effective intervention for stuttering.

Many have attempted to identify which, out of the many procedures presently used to remediate stuttering, would be the most effective in alleviating dysfluent speech episodes (e.g., Onslow, 1992). Often this type of approach has pitted techniques such as the presentation of AAF and those interventions traditionally viewed as being derived from a behaviour modification background against one another. However, this seems wrongheaded in two distinct ways. First, these different interventions, in themselves, are not competing theories concerning stuttering (although they may well be drawn from very different theoretical backgrounds). Rather they are merely different techniques addressing possibly different aspects of the relationship between the stuttering response and the environmental controllers of that response. Second, it is unlikely that any one procedure, like those therapeutic techniques associated with AAF, or those derived from operant conditioning methods, meet the requirements of a successful intervention. For example, AAF, especially in the form of frequency-shifted feedback (FSF), is a quick and effective way of achieving fluent speech (as are other forms of altered auditory feedback, slowed speech, regulated breathing, etc.). However, it would not be expected that FSF alone typically would produce long-term benefits, unless used with appropriate regimes for response maintenance. On the other hand, operant conditioning methods, long-term therapy, and so on, appear to be more

[1]It is not to be implied that AAF techniques may not be considered as operant in themselves, merely that such a view is not one that is expressed to any widespread extent either in the contemporary speech science, or in the current operant literature.

effective at achieving the long-term maintenance of fluency, at least when appropriate methods for enhancing transfer of behaviour from the intervention to 'everyday' situations are applied. Yet these procedures are more limited than they otherwise might be, because they often lack a clear cut response prompt, like that provided by FSF, to generate quickly the appropriate fluent speech to reinforce.

It should be noted that there are many instances of interventions for stuttering in which the antecedents of an *inappropriate* speech response have been identified (e.g., Azrin & Nunn, 1974). However, it is the thesis presented here that identifying the antecedents of dysfluencies (inappropriate behaviour) will lead to a quite different range of intervention possibilities than would the identification of the antecedents (including prompts) of fluent speech episodes. In particular, sole focus on the identification of the antecedents of dysfluencies will promote the subsequent use of punishment for those dysfluencies, rather than reinforcement of the appropriate fluent speech episodes. The use of punishment, which underlies many operant-based methods for the treatment of stuttering, potentially including habit reversal, may well be problematic in number of ways, and for a number of critical populations of stutterers. These vulnerable populations include children and the learning disabled. In contrast, the FSF techniques to be discussed in the present review, although limited in terms of their long-term maintenance of fluent speech episodes, not only identify the antecedents of dysfluency, but also apply prompts to promote the fluent alternative behaviours that can be reinforced directly.

Behaviour Modification Techniques

As noted above, there are many approaches that have been adopted for the treatment of stuttering based on the principles of behaviour modification. Two of the approaches that have attracted great empirical and clinical interest are, habit reversal which is sometimes referred to as regulated breathing (see Azrin & Nunn, 1974; Miltenberger et al., 1998), and the application of time-out punishment for stuttering (e.g., Onslow et al., 1997). The overall effectiveness of such techniques has been reviewed elsewhere, and the many factors that might influence the effectiveness of these interventions have been established reasonably well (see Miltenberger et al., 1998; Onslow, 1992; Prins & Hubbard, 1988, for reviews). Although such procedures offer great benefits to stutterers, there is always the need for discussion of the extent that there are possible omissions in these techniques that could be rectified by the adoption of FSF technology. The present article limits its discussion of such procedures to these possible omissions.

In the present context of suggesting the need to produce a combined FSF-operant intervention for stuttering, two issues will be drawn out in a brief review of operant-based techniques. The first issue involves concerns about the effectiveness of these interventions in attenuating stuttering in potentially critical populations (especially relevant here is recent work on time-out procedures). The second issue concerns the long-term effectiveness of punishment-based methods in promoting fluent speech. Both concerns are produced since current applied behavioural methods typically have not identified the antecedents which are associated with, or promote (prompt), fluent speech, as opposed to dysfluent speech episodes.

Habit Reversal/Regulated Breathing

Regulated breathing is a specific intervention for stuttering problems, and can be viewed as a version of the habit reversal procedure introduced by Azrin and Nunn (1973). The regulated breathing intervention consists of four, multi-component phases of treatment. In the first phase, the stutterer is helped to recognise the conditions under which their stuttering is likely to occur. Following this phase, the stutterer is taught to engage in a competing

response at those time when a speech dysfluency is liable to occur. In this intervention, the response taught to compete with the dysfluency is for the stutterer to take deliberate slow breaths prior to talking again, and when the stutterer is ready to recommence talking, they are taught to precede the first word with a slight exhalation of breath. The third phase of the intervention package is designed to enhance the motivation of the stutterer to engage in this process, by highlighting both the advantages of not stuttering, and the disadvantages of stuttering (i.e. social embarrassment). It should be noted that this phase has been removed in a simplified version of the procedure (e.g., Wagaman et al., 1993). The last phase of the regulated breathing approach is to give praise and social support for the stutterer in carrying out this competing response. The final procedure adopted by regulated breathing approaches is one in which the treated individual makes a 'public display' of their fluency. This putatively demonstrated their skills, and resulted in social reinforcement. However, although social reinforcement for fluency is certainly possible under these circumstances, it was not empirically demonstrated in studies of regulated breathing, and must remain an assumption. Thus, at no time can it be categorically demonstrated that fluent speech is either prompted or reinforced by regulated breathing approachers, rather the mechanism of action in producing fluent speech could be any one from a number of untested possibilities (see below).

There are a number of assessments of the effectiveness of this approach in relieving stuttering, with both adult and child stutterers. These accounts have used both the full four-phase intervention (e.g., Azrin, Nunn, & Frantz, 1979; Saint-Lauret & Ladouceur, 1987), and the simplified three-phase version of the treatment (e.g., Wagaman et al., 1993; 1995). Examination of these reports suggests some evidence for the effectiveness of the treatment when applied to adults, but a rather mixed pattern of effectiveness when children have been treated. For example, in the report by Wagaman et al. (1993), eight children were treated with this intervention, and all showed significant reductions in stuttering during at a one-year follow-up assessment. In a subsequent examination of these children, seven of the eight children were still below their initial baseline levels of stuttering three and a half years following the treatment (Wagaman et al., 1995). A similar pattern of results was noted by Elliot et al. (1998), with three out of four children in this study showing marked reductions in stuttering, and the fourth showing evidence of not complying with the intervention approach.

In contrast to the above successes, several other reports concerning the effectiveness of the intervention have shown only a patchy profile of success. For example, Miltenberger et al. (1996) noted only one of the two subjects examined in their study showed any improvement in speech dysfluency. Similarly, Woods, Fuqua, and Waltz (1997) noted that, in a case study of a child with a developmental disability, there was little sign of improvement. In fact, children with developmental delay may be particularly difficult to treat with habit reversal procedures, in general (see Miltenberger et al., 1998). Least these comments lead to an unfair assessment of the reported outcomes of regulated breathing studies, it should be noted that there are at least twenty studies of this procedure that do report positive outcomes for stuttering. However, the major problem is one of a lack of appropriate comparison control groups or conditions in these studies.

Unfortunately, even in the studies of regulated breathing which have used a large number of subjects, the effectiveness of the treatment has rarely been compared with controls receiving an appropriate attention placebo. The pretreatment baseline assessments, often used as evidence against such an alternative interpretation of the interventions effectiveness, lack the treatment credibility essential for such a control. Even leaving aside this major concern about the experimental designs of studies intended to assess regulated breathing approaches to stuttering, it is not entirely clear which of the phases and/or components of the intervention are necessary for the treatment to be effective. With adults, it appears that the

final two phases of the intervention can be omitted without apparent detriment to the interventions effectiveness. In contrast, social support and reinforcement appears important for the success of the approach with children (see Miltenberger et al., 1998, for a review).

These findings have implications for the mechanisms whereby this intervention is effecting an attenuation of speech dysfluency. For example, it seems fundamentally unlikely that reinforcement is serving to promote fluent speech directly. The failure to show conclusively that social support and/or reinforcement is necessary for the success of the intervention would appear fatally damaging to any explanation based on the reinforcement of fluent speech patterns. Two alternatives were suggested by Miltenberger et al. (1998) in their review of habit reversal, and these possibilities seem more likely to be critical in producing the success of the intervention (although it should be noted that these alternatives are equally unproven, given the current state of research into this area). The first suggestion is that the competing response (i.e. regulated breathing) is set up as a reinforced alternative response to stuttering. In addition to the social support provided by the therapist during the intervention, the competing response is assumed to be maintained by whatever contingencies reinforce the stuttering response. This view rests on two assumptions that would imply that reinforcement contingencies are necessary to reinforce this response (for which there is little evidence, if any). It would also suggest that the operant of ‘regulated breathing’ would be substitutable for the operant of ‘stuttering’. This is unlikely given that the consequences for regulated breathing and stuttering may well be different from one another.

The second suggestion made by Miltenberger et al. (1998) concerning the mechanisms responsible for the effectiveness of regulated breathing is that regulated breathing works through punishment[2] of the stuttering response. This could be due to the response cost involved in engaging in regulated breathing after a stuttering episode (Friman & Polivy, 1995). Alternatively, it could be that the requirement to stop a speech episode, and start the same episode again later, serves rather like an overcorrection procedure (Miltenberger & Fuqua, 1981). Finally, it could be that the requirement to stop speaking may serve as a time-out from the reinforcement contingencies which maintain conversational speech (see below). These punishment contingencies are not mutually exclusive and some or all of these could be working for the same individual at different times.

If punishment is serving to reduce the occurrence of stuttering in a regulated breathing approach, then there are two immediate problems which appear to face this intervention. First, it is unclear that fluent speech would be promoted by the treatment, as opposed to a mere reduction in a particular set of dysfluencies. Inspection of the data obtained from these studies suggest that the actual speech patterns are not recorded, but rather the number of dysfluencies initially targeted are recorded. It is possible to argue that as dysfluencies decrease, and that speech rate increases, that normal speech is occurring. However, unless fluent speech is measured, this remains an assumption. Second, it is unclear that if regulated breathing incorporates a punishment component, it not be effective in anything other than the short-term, unless appropriate reinforcement also is received for the emission of the appropriate response. This point is taken up in more detail below. Although there are instances of long-term effectiveness of the treatment, these are sporadic, not necessarily attributable to the intervention, and apparently only effective in certain cases.

Thus, although there is some evidence for the effectiveness of this intervention, it may not be as effective as it would otherwise be, because it concentrates on identifying conditions under which dysfluencies occur, and then potentially subjects these behaviours to

[2]In this context punishment refers to the reduction in the rate at which behaviour is emitted when a stimulus follows the emission of that type of behaviour.

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punishment, rather than targeting and promoting an alternative fluent response, at those points, and reinforcing this fluent response. As will be noted below, this is precisely where AAF techniques can help.[3]

Time-out Punishment

Typically, in this approach to the reduction of stuttering, when a dysfluency occurs in ongoing speech, the therapist using this intervention will signal this to the stutterer, and then will refrain from engaging in any conversation with the stutterer for a specified period of time. This approach was investigated reasonably widely some twenty years ago, but since this time research reports have thinned in the literature. This is not to say that the approach is still not used as an intervention, often in conjunction with positive reinforcement, as in the Lidcome Programme (Onslow & Packman, 1999). Indeed, there may well be some scope for its use for some classes of stuttering (Costello & Hurst, 1981; Howell, Au-Yeung, Davis, Charles, Sackin, Williams, & Reed, 1999). The application of time-out from speaking is claimed to be an effective method of suppressing the incidence of stuttering. For example, Costello (1975) noted that such a time-out procedure reduced the incidence stuttering to near zero levels in a clinical situation. James (1981) reported that self-administered time-out procedures maintained fluent speech outside the clinic for at least a year. Nittrouer and Cheney (1984) found that punishment was more immediately effective than reinforcement in the reduction of dysfluencies.

Despite some reports of the successful use of time-out procedures, it is equally clear that such a procedure does not work well with all subjects (see James, 1981; Prins & Hubbard, 1988, for a review). Of course, the failure to be effective with all populations is not, in itself, an argument against the effectiveness of operant procedures. Moreover, behaviour modification procedures which focus on the reduction of the incidence of stuttering through the use of time-out procedures (e.g., Onslow et al., 1997), run a risk of impacting on stuttering only in the short term. This latter problem is potentially a more major one, and the suggestion that this does occur has some support from the literature.

There has been a long debate in the operant conditioning literature concerning the efficacy and appropriateness of punishment in removing behaviours from the repertoire of an individual. Most commentators agreeing that, in the absence of concurrent reinforcement of appropriate behaviours, with the mild punishments typically available for use on humans (e.g., time out and verbal reprimands), behavioural suppression will only be temporary, and not permanent (Azrin & Holz, 1966). For example, Rolider, Cummings, and van Houten (1991) noted that punished behaviour does not easily generalise from one setting to another. In order to produce less transient alteration in behaviour, punishment is often combined with positive reinforcement for alternative behaviours (Thompson, Iwata, Conners, & Roscoe, 1999). Inspection of the data presented by Onslow et al. (1997) suggests that this may well be the case in this report (see also, Martin & Bernt, 1970, for a similar failure to maintain fluent speech on withdrawal of a time-out procedure). Of course, it could be argued that as these two studies were both laboratory-based studies, and not treatment evaluation studies, long-term effects were not intended or expected. Although, if this were claimed, the external validity of such laboratory tests would be brought into question. In a treatment-evaluation study of the ameliorative effects of short-term speech therapy on stuttering, James, Ricciardelli, Rogers, and Hunter (1989) also report that there was relapse following the withdrawal of the procedure, during which the incidence of stuttering increased from the

[3]It may be that the regulated breathing acts merely to slow speech down, a factor know to help fluency in stuttering populations. The slowed speech is then likely to be fluent, and can be reinforced, which will, in turn, promote faster fluent speech in the long term. If this is the case, then this technique may well work in precisely the same way as AAF, although the controlling variables are left to chance rather than the manipulation of the therapist/experimenter.

levels achieved at the end of the intervention, suggesting the need for continued intervention. Newman (1987) studied the effect of punishment (verbal reprimands) for repetition in speech. The introduction of punishment resulted in an increase in avoidance behaviours, lowered speech rate, and a less spontaneous speech style. This result was also noted in observations of clinical stutterers prior to an intervention (Woods et al., 1997).[4]

The application of punishment in an operant situation also has been found to generate behaviours which may well be incompatible with the production of the desired behaviour. For example, the use of punishing stimuli, if they are too severe, can result in aggression and frustration in the client (Mayhew & Harris, 1978). It should be noted that, in the case of time-out from speaking, it is reported that this particular consequence, when applied after a period of dysfluency, is not apparently aversive to the client (Costello, 1975). However, even in cases where the consequences that serve empirically as punishers, in that they reduce the level of observed behaviour on which they are targeted (rather than being punishers by virtue of their aversive hedonic properties), the application of a stimulus which suppresses one behaviour will often lead to the emergence of other, potentially equally unhelpful behaviours (Dunham, 1971).

Reinforcement

Habit reversal and punishment are only two weapons in the arsenal of the behaviour modifier. Moreover, punishment is the least favoured approach to changing behaviour for many reasons, including, in addition to those mentioned above, ethical concerns (see Pierce & Epling, 1995; Reed & Yoshino, 2000). The application of positive reinforcement for fluent episodes may appear to overcome some of the issues raised by the use of punishment of dysfluent speech episodes. A number of reports have focused on the effectiveness of such a reinforcement-based treatment for stuttering. For example, Andrews, Howie, Dosza, and Guitar (1982) used money as a reinforcer for fluent speech episodes with adult stutterers. They reported an increase in fluency, although the outcome of this study is made difficult to assess by the use of crude measures of speech fluency (see Onslow et al., 1997). Other studies have focused on the use of response-contingent stimulation either with children (e.g., Onslow, Andrews, & Lincoln, 1994, a report which also included time-out for stuttering) or adults (e.g., Guitar, 1998; Ryan & van Kirk, 1974). Typically such stimulation takes the form of a verbal praise for achieving a specified period free of dysfluent speech.

The effectiveness of such interventions, however, appears to be questionable with respect to the issue of whether or not the increase in fluency, and concomitant attenuation of stuttering, is achieved *solely* through the application of reinforcement. Many of the studies lack adequate controls in order to judge fully the effectiveness of the manipulation. For example, Onslow et al. (1994) report the withdrawal of a large section of the control group from their study, in order that they too could start treatment. Onslow et al. (1994) comment about the inappropriate nature of clinical trials, ethically, to assess the effects of an intervention[5].

One study which does appear to facilitate fluent speech through the use of positive reinforcement is that reported by Ryan and van Kirk (1974). However, closer inspection of this paper reveals that fluency was only improved by reinforcement once the fluent speech had been generated though the use of AAF techniques. In fact, many such reinforcement-based procedures have already turned to the use of such AAF methods to enhance their effectiveness over and above that which could be achieved through the use of reinforcement

[4]These effects of punishment may be contrasted with a lack of such effects in regulated breathing, in which there are no reported instances of side effects. This suggests that regulated breathing may work through other mechanisms as well as punishment.
[5]However, this is a purely practical problem that can be solved by the adoption of the delayed-treatment matched-control group used in much work that experimentally assesses interventions in Educational Psychology.

alone (see Guitar, 1998; Ryan, 1992). Most of these interventions employ delayed auditory feedback as the AAF procedure of choice (e.g., Ryan & Van Kirk, 1983). Unfortunately, this form of AAF has been found to result in altered patterns of speech (see Howell, 1990).

One potential reason for the adoption of AAF procedures in operant work, is that the fluent speech response may be a particularly difficult response to learn through reinforcement. Examination of the early intervention procedures that are typically used with those that stutter, reveal that the initial treatment phase can last between two to three months before fluency has reached a level in which the treatment can be withdrawn, and the follow up assessment period started (see Onslow et al., 1994). The relative slowness of reinforcement as an intervention for stuttering is illustrated by the finding reported by Nittrouer and Cheney (1984), who noted that punishment procedures are far quicker at reducing the rate of dysfluency than are reinforcement-based procedures.

In summary, it can be suggested that techniques often used by operant psychologists suffer in two ways. If such interventions focus on the removal of dysfluency through the use of punishment procedures, they may impact temporally on the dysfluency, and could generate equally unwanted behaviours in the process. It should be noted, of course, that the problem of transfer and maintenance of behaviours is not limited to punishment procedures, but has been noted to occur in the context of stuttering therapy with many operant procedures (see Curlee, 1993; Ingham, 1993a). Alternatively, the currently used operant-based techniques can focus on the reinforcement of fluency, but in this case they may take a substantial period of time to generate any improvement in speech.

Altered Auditory Feedback Techniques

Frequency-shifted feedback is a particular form of the genera of techniques involving presentation of altered auditory feedback. As well as frequency shifted feedback, this class of techniques includes delayed auditory feedback discussed earlier. In their pure form, these techniques involve transducing the speaker's own voice, electronically altering the sound, and playing the altered version of the voice back to the speaker.[6] In the delayed auditory feedback technique, the voice is recorded by microphone, and electronically delayed before it is played back to the speaker over headphones (see Craven & Ryan, 1984, for a description of a portable technique employing AAF procedures).

Frequency shifted feedback also involves recording speech with a microphone, shifting the speech spectrum down, and replaying the resulting sound over headphones as described before. Electronic equipment is commercially available (e.g., the Digitech studio model 400 allows delays and frequency shifts, as well as other signal alterations to be selected). In experimental therapy sessions, where the speakers wear the headphones throughout, they hear a frequency shifted version of their voice whenever they speak. Studies have reported that electronically altering the voice feedback to a speaker who stutters improves their fluency. One such alteration is to shift the voice in frequency (frequency shifted feedback). When this is done, it dramatically and immediately enhances the fluency of people who stutter (Howell, 1990; Howell, El-Yaniv & Powell, 1987; Howell, Sackin & Williams, in press; Kalinowski, Armson, Mieszkowski, Stuart & Gracco, 1993; Kalinowski, Armson &

[6]A case has been made that the controlling variable when a speaker's voice is altered is production of a concurrent sound segregated from the speaker's voice, and not any inherent properties of the voice itself (Howell, Powell & Khan, 1983). An argument that it is concurrent sound, and not any properties of the speaker's own voice, is that though the segregated sound produced under delayed auditory feedback is created by a temporal shift of the speaker's voice, any sound that stands in the same asynchronous relationship with the voice has similar disruptive effects on speech control (Howell & Archer, 1984). The importance of the concurrent sound view is that it draws attention to the similarity with other techniques that involve stutterers hearing sounds while they speak, such as metronome clicks (Howell & El-Yaniv, 1987), choral speaking, masking noises (Cherry & Sayers, 1956), and so on (see Stager & Ludlow, 1993, for a comparison of these techniques).

Stuart, 1995; Kalinowski, Stuart, Sark & Armson, 1996; Stuart, Kalinowski, Armson, Stenstrom, & Jones 1996).

Observationally, as seen in the video distributed by Kalinowski et al., the effects of this manipulation, when exposure is limited to the short term, are mainly restricted to the period during which the altered voice is heard. Two recent reports have sought to investigate whether longer term exposure to FSF in people who stutter produces sustainable improvements that generalize to unaided (i.e. without FSF) speaking conditions (Armson & Stuart, 1998; Ingham, Moglia, Frank, Ingham, & Cordes, 1997). In both of these papers, FSF was presented continuously for a period of time, and the unaided speech of people who stutter was assessed to see whether FSF produced an improvement in their fluency. Most speakers in the Ingham et al. (1997) study reported that their fluency improved short term (although it should be noted that one of the subjects in this study failed to respond at all to the FSF treatment). To quote the authors' comments about the short term effects in three of their speakers: Subject E.S. found that "he could speak more easily during the FSF conditions .."; Subject F.G. "did show some indication of a reduction of stuttering"; and, Subject A.G. "showed a dramatic reduction in stuttering during both FSF conditions". The fourth, and last, subject (E.O.) provided an "almost textbook example" of carry over from training to post training; indicating, both short-term and long-term fluency improvements.

These two studies show that there is a degree of consistency in the immediate response to FSF. This effect is noted either in subjects' reports, and/or in the perceptual assessments made by the experimenters. Yet despite the long-term success of this manipulation with Subject E.O., both of the studies mentioned above reported that, on the whole, extended exposure to FSF did not produce any sustained improvement across subjects in perceptually-assessed speech fluency. However, it can be disputed whether the experimental procedures have been conducted in a way that is likely to lead to the fluency improvements persisting, and this is a point that applies equally well to the operant procedures described above. Given the pervasive importance of this issue, it will be taken up in more detail later in this article.

It appears as if the use of FSF does have an immediate and dramatic effect on the speakers fluency. There are, of course, many possible sources of the influence of FSF on speech. Some of these suggestions focus on what may be termed broadly as cognitive mechanisms, however, the present paper presents an attempt to conceptualise the use of auditory feedback techniques within a framework that could promote integration with behavioural approaches. To this end, the role of FSF as a stimulus impacting on behaviour should be considered. The conceptualisation of the manner in which such an FSF stimulus works is somewhat complicated by the means through which FSF is applied during an episode of speech. Typically, during an FSF session the feedback is applied either throughout a session every time the subject speaks, or it is applied after the detection of a dysfluent episode. In one sense, the FSF may be considered as a consequence for behaviour, since it is applied contingently upon the emission of speech, especially dysfluent speech, that is the occurrence of FSF is dependent upon the emission of speech to transform. In contrast, FSF also may be considered as an antecedent to fluent speech, since to occurs prior to the emergence of this response (but following the emissions of dysfluent speech). Thus, the FSF could be thought of as a prompt to fluent speech. This is the view taken by the present article, and is a view that could under pin a successful integration of an FSF method into an operant procedure for the treatment of stuttering. One potential model of the manner in which FSF could be employed in this context is outlined below. This view is preferred to the conceptualisation of FSF as a consequence for a number of reasons. Firstly, by analogy to other forms of prompting, such as physical prompts, which are used after the emission of an incorrect response (i.e. either an inappropriate action, or just the subject doing something other than that defined as correct in the experimental situation, such as nothing). Such physical prompts

are taken to be antecedents of appropriate responding, despite the fact that they occur subsequently to the emission of an incorrect response. Moreover, it is important to stress that just because the FSF is applied after a speech response is emitted, it is not a consequence for every type of speech response. It may well be that dysfluencies and fluent speech responses are two very different operants. That FSF acts as a consequence to one of these operants, does not mean that this is how it is acting to the other.

However, prior to outlining a conception of FSF as a response prompt, it is worth considering the potential mode of action of FSF as a response consequence. The application of FSF occurs after the detection of a period of dysfluency. It may be that the altered feedback is acting to punish the response on which it is contingent, so reducing the occurrence of dysfluent speech. In the absence of empirical work this explanation must remain a possibility, however, there are a number of reasons to doubt that this is the prime mechanism of action, at least if FSF is employed (although these reasons may not apply to all forms of AAF). First, the FSF can be scheduled to occur immediately at the onset of a dysfluent episode, rather than at its conclusion. That such a scheduling is effective in reducing the incidence of stuttering suggests that the FSF does not need to be made consequent on the entire dysfluent response in order to reduce such episodes. Of course, the FSF could be punishing the instigation of a 'prewired' motor response, which was already planned, and which was merely in the processes of being implemented. This may be equally effective as punishing the entire sequence once it had been completed. Second, it is reported by subjects that the FSF procedure is not hedonically aversive. Although, as mentioned above, this would not rule out the possibility that FSF serves as an *empirically* defined punisher. Finally, if this technique were acting to suppress dysfluency though punishment, it is unlikely that fluent speech would spontaneously occur in the absence of a punished response. Punishment will only suppress an unwanted behaviour, and it does not establish desired behaviours by itself. Taken together, these reasons suggest that it is unlikely the FSF procedure is serving to affect speech through punishment.

Conceptualisation of FSF mechanisms

An alterative view of the mechanism at work during FSF is arrived at by examination of the operant 'three-term contingency' model of behaviour (see Boakes & Halliday, 1970; Catania, 1984). This model suggests that some setting occasion serves to increase the probability that a particular behaviour will be emitted, and that the emission of this behaviour will result in reinforcement. This reinforcement will, in turn, strengthen the tendency to emit this behaviour again under similar circumstances. In the context of this three-term contingency model, FSF could be seen as an occasion setting stimulus, or prompt, to a behaviour (i.e. fluent speech). This fluent speech could then receive reinforcement delivered though the application of an operant-based therapeutic technique. The use of such prompts is widespread in the behaviour modification literature, and it is worth examining, briefly, each of the components of this model with respect to FSF.

Prompt—There are a number of AAF methods available to use in this context. In order to serve as a prompt to fluent speech, it would have to be shown that FSF did indeed prompt fluent speech, and did not just suppress dysfluent speech. The reasons for doubting that FSF works to produce fluent speech through the punishment of dysfluency are reviewed above. However, it still remains to show that the speech prompted by FSF is 'normal'. What is known about those aspects of the speech response under FSF that have been investigated, indicates that such FSF-prompted speech operates within the 'normal' motor limits. This stands in contrast with other forms of AAF. With FSF, on the other hand, speech loudness is normal (i.e. speakers with FSF do not shout, Howell, 1990), and speakers under FSF do not speak slowly (i.e. their rate of speech does not change, Kalinowski et al., 1996). Indeed, it

has been reported that not only do speakers under FSF not speak slowly, they actually can maintain fluency when the global rate of speech is accelerated; that is, fluency under FSF is enhanced even when speakers are required to speak at an increased rate (Kalinowski et al., 1996; Howell & Sackin, in press). It might also be noted that the application of reinforcement-based techniques to stuttering also lead to speech which is perceptually distinct from 'normally' occurring speech (Ingham, 1993a).

The second issue which requires some comment is how FSF prompts such a speech response. One possibility is that those who stutter are actually attempting to speak too quickly. This could lead to plans not being ready for motor execution when they are required (Au-Yeung, Howell, & Pilgrim, 1998). Procedures that slow down the speech process may allow planning and execution of the speech response to get back into synchrony (Howell & Sackin, in press).[7] The application of the FSF only has to occur locally at the point of dysfluency, and is not necessarily inconsistent with Kalinowski et al.'s claim that fluency under FSF is enhanced even when speakers are required to speak at an increased rate.

Thus, as a prompt FSF appears to be able to deliver an appropriate form of speech response for potential reinforcement. Moreover, it also appears to have some advantages over and above other forms of AAF, and in comparison to the use of reinforcement only.

Response—It is important to have some idea of the nature of the response that is being prompted by the application of FSF. There are two issues which it is important to consider in the context of a model of how FSF could be used as part of an integrated therapy for stuttering. The first concerns what type of response is to be measured during such an episode, and the second concerns the type of dysfluency that should provoke the use of FSF as a prompt to fluency. The two are, of course, intimately connected.

The first issue, about what to measure will, in part, depend upon theoretical view of the nature of the speech response which is held. A failure to fully specify the nature of the response has been taken as a stumbling block to the development of behavioural analysis (see Siegel, 1993). Methods that are suitable for research purposes have been developed and described elsewhere (e.g., Howell, AuYeung, Sackin, Glenn, & Rustin, 1997).

With respect to the second issue, one possibility is to present the prompt during 'live' assessment of perceptually fluent and dysfluent regions of speech. Alternatively, the rate of the speaker's speech could be monitored on-line, and the FSF applied when this rate passes some predetermined criterion. The latter has the advantage of automacy, removing the potential for erroneously applying the prompt. However, if the former approach were adopted, then decisions about when the FSF prompt is applied can be recorded, and can be fully assessed at some later time, to ensure accuracy of application of the FSF prompt to fluent speech. Using this procedure, it is highly likely that some instances of dysfluency will be missed, or some instances of fluent speech may be considered as dysfluent, and the prompt inappropriately applied. However, this may not be such a problem as it first appears. The optimum level of prompt application during Behaviour Modification is still a matter a some empirical debate (Cuvo, 1988). What does appear to be clear, however, is that the consistent application of an external prompt can, in some circumstances, come to overshadow the naturally occurring or scheduled events that are meant to control the targeted behaviour. That is, behaviour becomes dependent upon the presence of the prompt, and, on removal of the prompt, will collapse back to its previous, pre-intervention levels (e.g., see Ray & Sidman, 1970).

[7]Such a process could be given another terminology, concerning incompatibility of competing responses (overt and covert), if the orientation of the reader is more behavioural.

Reinforcement—In AAF methods, like those described in the papers concerned with FSF (e.g.,Howell et al., 1987; Kalinowski et al., 1996), there is often little explicit reinforcement given to the subject for the production of fluent speech episodes. This may, of course, be one of the reasons why this technique has been noted to fail to generate much in the way of sustained improvement once the AAF is withdrawn. However, it has been noted that the use of some forms of AAF have led to an improvement in fluency that survives transfer from the clinical setting. In explaining these results, it is important to remember that the emission of some behaviours may be 'self-reinforcing'. For example, some have maintained that responses such as speaking fluently (Haroldson, Martin & Starr, 1968), play in children (Harrington, 1987) and some activities in nonhumans (Sherwin, 1998) are reinforcing 'in themselves'. Quite what mechanism produces a 'self-reinforcing' event is unclear. However, it may be connected with the phenomenon of response deprivation, in which an animal deprived of the opportunity to engage in a particular activity, will emit responses if they lead to a chance to engage in that activity. That is, the activity becomes reinforcing (Timberlake & Allison, 1974). Similar phenomena have been observed in setting up behaviour modification programmes with human subjects (see Lattal, 1969). It may be that the necessary reduction in fluent speech episodes occasioned by a high incidence of stuttering will make such fluent episodes reinforcing 'in themselves'. Thus, the emission of fluent speech, in the context of a stutterer's behaviour, may well be a self-reinforcing behaviour. Since fluent speech would only be reinforcing due to response deprivation in the presence of stuttering incidences, then this would explain why fluent speech is always emitted.

In addition, there may be other forms of implicit reinforcement in a situation in which fluency of speaking is achieved. Social cues between therapist and stutterer may well be acting to reinforce the behaviour, without the explicit awareness of either (cf. Prins & Hubbard, 1988). Alternatively, the removal of dysfluency may be reinforcing for the avoidance of potential embarrassment and/or distress suffered by the stutterer. Thus, even in the absence of explicit verbal praise, money, or response-contingent stimulation of other types, there is still reason to suggest that improvements through the application of AAF may be reinforced. However, such procedures would undoubtedly benefit from a more objective and explicit use of reinforcement (as documented above).

New Opportunities

There is little doubt that operant techniques have brought improvements to the quality of life of those previously thought to be beyond help from any psychological intervention. However, it is equally clear that behaviour modification procedures require assistance in gaining control over certain classes of response. The above argument suggests that both the FSF techniques and operant condition procedures have some claim to success in the amelioration of stuttering, but could both benefit from a combination of their respective strengths. This is not to say that they should be thoughtlessly applied together, but rather could be used in tandem in a theoretically sound manner, and practically in ways to be determined through empirical study. Although it is unwise to speculate overly in the absence of data, two issues appear to deserve brief mention in the context of such a combined approach to therapy for stuttering: firstly, the use of FSF as a response prompt; and secondly, the manners in which such a therapy could be made more effective in the long term.

Although the suggestion for an intervention for stuttering is still speculative, it may help to outline one method through which such a combined procedure may work in practice. Within a therapeutic session, the subject could be encouraged to engage in speech, through conversation or reading. Previous analysis of the types of stimuli that could serve as reinforcers would ensure that the delivery of reinforcement is not disruptive to the ongoing

speech of the subject. During the session, the subject would wear headphones, and apparatus capable of delivering FSF (described earlier) employed. The FSF could be delivered on-line when ever a dysfluent episode is detected, the resultant correction to fluency could then be reinforced.

It has long been established in the animal literature that certain classes of behaviour need first to be prompted before they can be reinforced. One of the initial demonstrations of a dissociation between classical and operant conditioning used just such a procedure (Miller & Konorski, 1928). Later, responses that are otherwise apparently intransigent to reinforcement (e.g., scratching in the rat) have been shown to be conditionable with the aid of a stimulus that initially elicits the desired response (Pearce, Colwill & Hall, 1978). In the human literature, it has also been shown that responses that occur at a low free-operant baseline rate are difficult to condition through behaviour modification techniques: Put simply, if a response is not emitted, it cannot be reinforced. In particular, those with learning disabilities usually require a response prompt in order to initially elicit the target behaviour, prior to its reinforcement (see Tennant, Cullen, & Hattersley, 1981). Such prompts take a variety of guises, ranging from verbal requests to physical guidance (e.g., Schoen, 1986).

Although not explicitly integrated into a model concerned with the ‘three-term contingency’, several previous reports of therapies used for the alleviation of stuttering, ostensively operant-based, have employed AAF techniques in order to promote the fluency of the stutterer prior to a rigorous application of a reinforcement system (e.g., Ryan & van Kirk, 1974; etc). In order that such procedures are applied appropriately, it would seem necessary that the operant therapists studied the most appropriate form of AAF to employ, in our opinion this would be FSF. Additionally, it would seem important to consider the most appropriate manner in which to schedule this prompt, in order to avoid some of the problems of prompt-controlled behaviour, discussed above, occurring in the context of such therapies. As many of these reports did not include a phase in which the AAF prompt was withdrawn, or indeed in which any long-term follow up was conducted, it is impossible to ascertain whether the prompt was appropriately applied. There is an extensive literature on the most appropriate manners in which to introduce and fade prompts in the context of behaviour modification (see Demchak, 1990, Reed & Wilson, under review, for reviews). These findings should be empirically studied with the context of treatments for stuttering. One especially promising line of work appears to focus on transferring prompts to fluency from the clinical context to the home context of the stutterer (Wagaman, Miltenberger, & Arndorfer, 1993).

Once fluent speech behaviour has been prompted and reinforced, the next issue is how to maintain its emission over the long term. If it is desired to prolong fluency, and reduce stuttering in the long term, across both time and place, then the partial reinforcement extinction effect (PREE) suggests that one effective way of doing this is to reinforce the required behaviour intermittently rather than continuously. Received wisdom suggests that partial reinforcement prolongs responding in extinction after training in discrete trail procedures. The literature relating to this effect is voluminous (see Amsel, 1992; Mackintosh, 1974), and it is found in many species including humans (see Morley, 1979, for a review). Partial reinforcement is a technique widely used in an attempt to prolong responding after behaviour modification (see, Kazdin & Polstner, 1973, for a review). Responding initially maintained by variable as opposed to fixed schedules are especially resistant to extinction (Shaw, 1987). Such procedures have been used also in a field close to speech therapy - the treatment of elective mutism, in which children will not speak in particular contexts (Baldwin & Cline, 1991, for a review).

There is, however, a question as to whether the same PREE is found after training on free-operant schedules of reinforcement. Reanalysis of some data, especially that involving free-operant responding, has thrown some doubt on this matter after it was found that behaviour appeared more resistant to extinction after continuous reinforcement (Huang, Krukar, & Miles, 1992; Nevin, 1988). There are, of course, other means of promoting behaviours beyond the therapeutic context, such as reinforcement-thinning and the fading in of naturally occurring reinforcers (see Sarafino, 1996, pp. 330-358, for a review). Such alternative methods require further investigation in the context of reinforcement-based therapies for stuttering.

Given all of the above, it appears that a potentially productive approach to the alleviation of stuttering is to first allow the development of the appropriate behaviour through the use of an FSF prompt, and then attempt to reinforce this behaviour, rather than attempting to eliminate the inappropriate stuttering behaviour. What would be the best way or ways of using FSF as a response prompt in an operant procedure remains to be empirically determined. However, rather than adopting a potentially facile confrontational stance, a more fruitful line of attack on this debilitating problem would be to focus on how to integrate two highly effective, but on their own incomplete, forms of treatment within a conceptually coherent framework concerning speech production and stuttering amelioration.

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