Abstract

Stuttering affects 70 million people worldwide, which is about 1% of the population. Altered auditory feedback (AAF) is a process by which an individual's auditory speech signal is electronically changed to temporarily increase the fluency of a person who stutters. For the purpose of this systematic review, AAF includes delayed auditory feedback (DAF) and frequency-altered feedback (FAF). This systematic review examines fluency enhancement in adults who stutter when using AAF devices. A review of the literature was searched using PubMed, Ovid MEDLINE, PsycINFO, and CINAHL databases with key search terms related to stuttering and AAF. Inclusion criteria included: 1) adults ages ≥ 18 years old who stutter, 2) comparison of altered auditory feedback forms and/or no altered auditory feedback forms in the treatment of stuttering, 3) inclusion of DAF or FAF, 4) outcomes related to aspects of stuttering or people who stutter (e.g., fluency level, speech naturalness, speech rate), and 5) experimental research. Studies were quality assessed and rated by the authors, yielding a total of 16 articles which were of 'moderate' quality overall. The conclusion is that AAF devices are generally effective in reducing stuttering frequency, with most notable fluency enhancement occurring during oral reading. The degree of fluency enhancement between individuals who stutter is variable and is influenced by factors such as stuttering severity. While research generally supports the use of AAF devices in reducing stuttering frequency, there are inconsistent findings regarding speech naturalness. AAF is likely most effective when used in conjunction with traditional speech therapy. Further research is needed to better understand the relationship between AAF and stuttering, particularly regarding unstructured speaking tasks and speech naturalness.

Introduction

Stuttering is a widespread condition that affects about 70 million people worldwide (Guitar, 2014). While its definitive etiology is unknown, many researchers attribute the cause of stuttering to genetics, speech and language, emotional trauma, and environmental factors (e.g., temperament and speaking demands). Although its treatment has evolved, there is no single intervention that best fits all individuals who stutter. One of the interventions used to treat stuttering is AAF, a process by which the auditory speech signal is electronically changed to temporarily increase the fluency of a person who stutters (Guitar, 2014).

AAF is an umbrella term known to include several different subtypes; however, for the purpose of this systematic review, the authors chose to focus on DAF and FAF. DAF is a condition through which speakers hear feedback of their own speech at a short time delay (Geetha, Sangeetha, Sundararaju, Sahana, Akshatha, & Antonye, 2017), whereas FAF modifies a speaker's frequency range, causing the individual to hear their speech at a higher or lower frequency than what is typical for him/her (Ingham, Moglia, Frank, Ingham, & Cordes, 1997). AAF generally occurs in a clinical setting, during which the client wears a set of headphones and speaks into a microphone. However, technological advances have led to the creation of miniaturized devices capable of delivering AAF inconspicuously (e.g., SpeechEasy®), which has increased clinician interest in this intervention (Stuart, Xia, Jiang, Kalinowski, & Rastatter, 2003).

The effect that AAF has on the speech of individuals who stutter has been one of the most researched topics in the field of stuttering since its initial use in the 1950s. Many researchers agree that both DAF and FAF can reduce stuttering frequency during oral reading (Armson, Kiefte, Mason & De Croos, 2006; Armson, Foote, Witt, Kalinowski, & Stuart, 1997;

Armson & Stuart, 1998; Kalinowski, Stuart, Wamsley, & Rastatter, 1999; Stuart, Kalinowski, Saltuklaroglu, & Guntpalli, 2006; Stuart, Kalinowski & Rastatter, 1997). Researchers have also found that the effects of AAF are not universal but are rather highly individualized. Depending on the individual client, the effects of AAF can entirely eliminate stuttering, reduce its severity, or have no effect at all (Armson et al., 2006).

Over the past 20 years, researchers have also studied how combinations of AAF affect stuttering, such as the combination or DAF and FAF. Devices like the SpeechEasy®, a small in-the-ear device, use this technology and are commercially available to people who stutter to increase their fluency in real-world settings (Lincoln, Packman, Onslow, & Jones, 2010). While research on the SpeechEasy® has been positive overall, there have been debates among researchers and the device's creators regarding its efficacy (Gallop & Runyan, 2012). To date, there has been no identified optimal temporal shift via DAF or frequency shift via FAF resulting in significant improvement in stuttering frequency (Lincoln et al., 2010).

The impact that AAF has on stuttering during spontaneous and conversational speech has only recently been assessed. A study conducted by O'Donnell, Armson, and Kiefte (2008) revealed that overall stuttering frequency decreased with AAF use, but the magnitude of this effect was less during spontaneous and conversational speech when compared to monologue speech tasks. Similarly, Armson and colleagues (2006) found that stuttering was reduced more in oral reading tasks than in conversational speech tasks. It should also be noted that studies on AAF have primarily focused on its effects during oral reading and monologue tasks, while research on AAF during conversational and spontaneous speech is lacking. For this reason, research has been unable to determine whether AAF use during conversational speech is beneficial.

Based on the existing literature, there is a lack of clarity on whether AAF increases fluency in people who stutter and, if so, whether these effects generalize outside of the clinical setting once AAF treatment has concluded. Additionally, devices such as the SpeechEasy® have shown mixed results regarding fluency increase in everyday life and yet are marketed as such. AAF devices such as this need to be further researched, as their effects may differ on an individual basis. Furthermore, much of the literature does not provide evidence to support the use of AAF in conversational and spontaneous speech tasks. The current systematic review aimed to explore the efficacy of AAF and its subtypes (i.e., DAF and FAF) on fluency and to identify the speaking contexts in which AAF is most effective for people who stutter.

Methods

Search Strategy

The articles of this systematic review were obtained through collective database searches of PubMed, Ovid MEDLINE, PsychINFO, and CINAHL, as accessed through the University of Vermont Dana Medical Library. No complimentary search strategies were used in conjunction with database searches. Searches were generated from August 2018 through March 2019. Search terms within each database (see Table 1) were guided by the PICO question (see Table 2), and inclusionary and exclusionary criteria were established by the authors (see Tables 3 and 4). Duplicate articles were removed from analysis, as well as articles with abstracts or titles that did not align with the inclusionary and exclusionary criteria of this systematic review. Articles were then read in further depth to determine qualification as per inclusionary and exclusionary criteria. The full text of the remaining articles were then read to assess for final determination of eligibility for the qualitative synthesis. The articles identified through the comprehensive database search were then subject to systematic screening of relevance to topic and inclusionary

and exclusionary criteria. Endnote was used as the primary means of bibliographic software storage.

Table 1. Search Terms

Subject Headings, Mesh headings, and Keywords		
AAF	Altered auditory feedback	Feedback
Sensory	Auditory	Delayed
Feedback	Frequency	Fluency disorders
Stutter		
Boolean Operators		
AND	OR	NOT
Comprehensive Database Article Count: 428		

Table 2. PICO Question

Population	Adults Who Stutter
Intervention	Altered Auditory Feedback
Comparison	Intra-group, inter-group
Outcome	Fluency

Inclusionary and Exclusionary Criteria

Preliminary database searches revealed that many studies of AAF and stuttering include participants of 18 years or older, with a considerably smaller number of studies that investigated younger populations. In light of this finding, studies included in this review were required to include participants of at least 18 years or older who stutter. All related aspects of stuttering, as opposed to just stuttering frequency, were included in this review, so as to understand the variety of ways fluency is affected by AAF. The use of some form of AAF of interest to the reviewers,

either DAF or FAF, had to be in included in the study, as this was the intervention under analysis. Experimental research was deemed an inclusionary criterion as well, as experimental designs often promote control over extraneous variables (see Table 3).

Studies were excluded from this review if their original text was in a language other than English, as all reviewers are monolingual English speakers. Studies only including participants who do not stutter were excluded, as this population would not align with the PICO question. Rationale for excluding participants with a prior history of AAF use was to eliminate confounding variables such as familiarity with AAF (see Table 4).

Table 3. Inclusionary Criteria

Population	Intervention and Comparison	Outcome	Study Type
Adults 18 years or older who stutter	Comparison of altered auditory feedback forms and/or no altered auditory feedback forms in the treatment of stuttering; use of DAF and/or FAF	Outcomes related to aspects of stuttering or people who stutter (e.g., fluency level)	Experimental research

Table 4. Exclusionary Criteria

Population	Study Type
Studies only including adults who do not stutter; participants with experience using AAF as a treatment for stuttering	Studies in languages other than English

Quality Assessment

Articles were assessed based on an adapted version of the *Assessing the Quality and Applicability of Systematic Reviews (AQASR)* checklist (Task Force on Systematic Review and Guidelines, 2013) to determine the individual quality of each article. All three authors of this systematic review completed an *AQASR* checklist for each of the included 16 articles and then

compared and discussed their subjective and objective assessments. Through this process, a quality assessment table was generated.

The results from the quality assessment table affect the cumulative results of this systematic review, as findings must be interpreted in light of the strength of the articles in which they derive. Through the consideration of data from each article and the article's quality, a clearer understanding of the relationship between AAF and stuttering can be established. Aspects of articles that were particularly applicable to this review were study design, population, number of participants, age range, method, type of speech sampled, results, *p*-value, and conclusion.

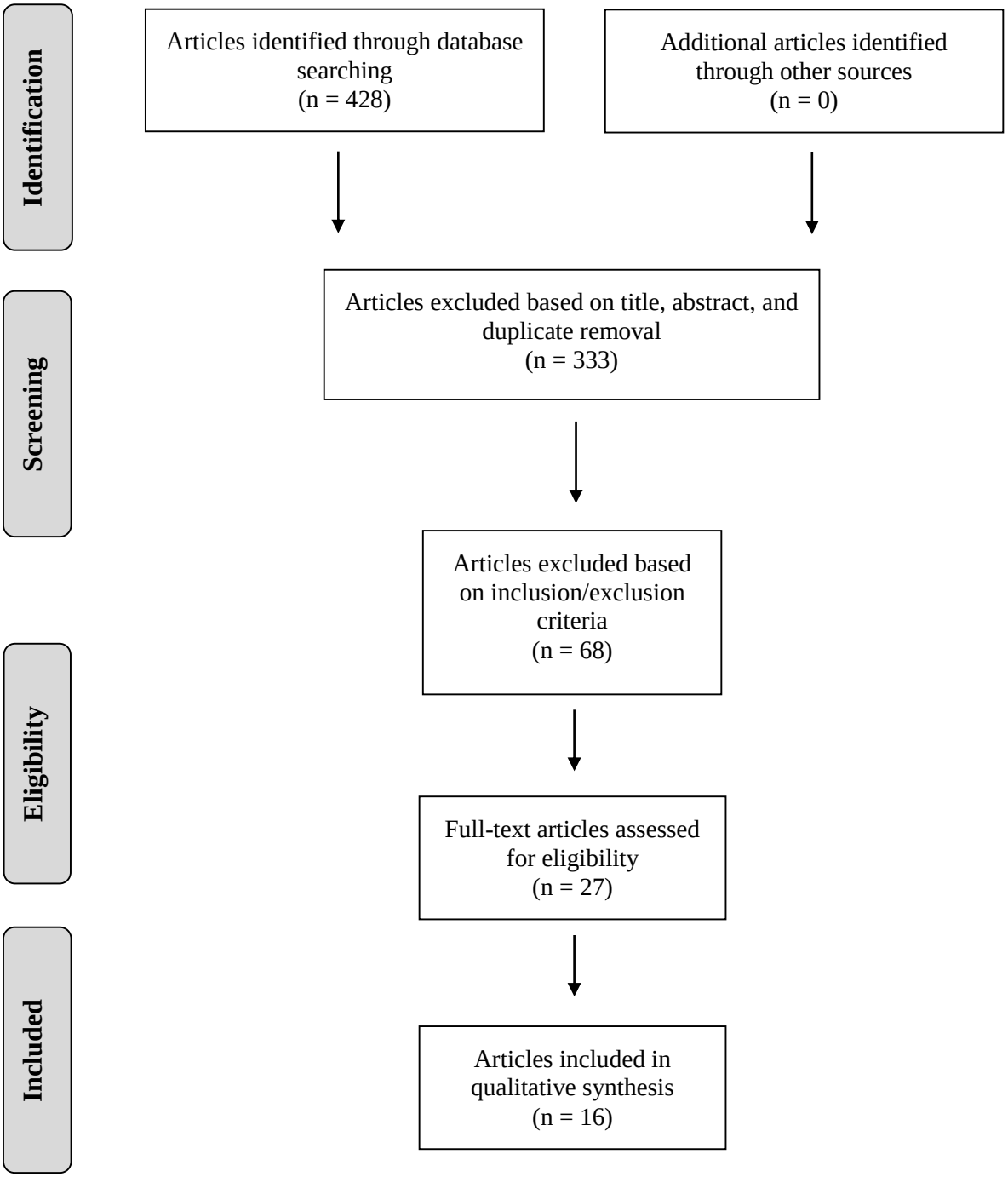
Results

Electronic searches of research databases (PubMed, Ovid MEDLINE, PsycINFO, and CINAHL) resulted in 428 references, which was reduced to 95 with the removal of duplicates and a screening of the articles based on their titles and abstracts. Sixty-eight articles were then removed based on inclusionary and exclusionary criteria, resulting in 27 full-text articles that were assessed for eligibility. A final collection of 16 articles was analyzed and included in this systematic review (see Figure 1).

Quality Assessment

It was determined that the overall quality of the studies was moderate (10 of 16 articles). Of the remaining six, three were of low quality, and three were of high quality. Most of the studies involved single-subject experiments, though others included randomized clinical trials (RCT) and quasi-experimental designs. Sample sizes were reported in all articles; the largest was 50 participants, and the smallest was 3 participants. Though all the studies included at least some description of their participants, specific participant inclusionary/exclusionary criteria were

Figure 1. PRISMA Flowchart of Included Studies



reported in only half the articles. The studies' interventions and outcome measures are discussed in all 16 articles.

Reliability measures are reported in 13 of the 16 articles; however, validity was only discussed in one article. Blinding was conducted in only 5 of the 16 articles, and the reviewers of this systematic review acknowledge the potential biases this creates (e.g., experimenter bias) and factored this into their analyses of article quality. A thorough discussion of study limitations is present in only half of the articles, and those that do not include this analysis were deemed to be of lower quality. In all 16 articles, the studies' results are clearly presented and interpreted. The quality assessment criteria considered most important in the determination of article quality were number of participants, reliability, discussion of blinding, and identification of limitations. For a full review of the quality assessment for each article, see Table 5.

Study Characteristics

The following participant characteristics are based on the information provided in the articles, and it should be noted that not all authors reported this data. Participants of the finalized studies ranged in age from 18-72. All studies included adults who stutter, while 3 also included adults who do not stutter, and 1 included an adult who clutters. Of the known data, 187 participants were male, and 39 were female, which is approximately a 4:1 ratio of males to females. A summary of the data extracted from each article in this review can be found in Table 6, including the study design, number of participants, age range of the participants, type(s) of speech and intervention(s) assessed, measured outcome(s), type(s) of outcome measurement, results, and conclusions.

Table 5. Quality Assessment of Studies

Authors (Year)	Study Design	Number of Participants	Inclusion/ Exclusion Criteria Included	Outcome Measures Described	Intervention Described/ Defined	Reliability Addressed	Validity Addressed	Blinding Addressed	Limitations Discussed	Clear Results Presented	Level of Quality
Armson & Kiefte (2008)	SS	31 PWS (20 males, 11 females)	No	Yes	Yes	Yes	No	No	No	Yes	Moderate
Foundas et al. (2013)	QE	24 males (14 PWS, 10 PNS)	Yes	Yes	Yes	Yes	No	No	Yes	Yes	High
Geetha et al. (2017)	QE	50 males (25 PWS, 25 PNS)	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	High
Hargrave et al. (1994)	SS	14 PWS (12 males, 2 females)	No	Yes	Yes	Yes	No	No	No	Yes	Moderate
Hudock & Kalinowski (2014)	SS	9 PWS (8 males, 1 female)	Yes	Yes	Yes	Yes	No	No	Yes	Yes	Moderate
Hutchinson & Burk (1973)	QE	27 (10 PNS, 9 PWS, 6 PWC, 2 PWS + PWC)	Yes	Yes	Yes	No	No	No	No	Yes	Moderate
Ingham et al. (1997)	SS	4 PWS (males)	No	Yes	Yes	Yes	No	No	Yes	Yes	Low
Lincoln et al. (2010)	SS	11 PWS (7 males, 4 females)	Yes	Yes	Yes	Yes	No	Yes	No	Yes	Moderate

Authors (Year)	Study Design	Number of Participants	Inclusion/ Exclusion Criteria Included	Outcome Measures Described	Intervention Described/ Defined	Reliability Addressed	Validity Addressed	Blinding Addressed	Limitations Discussed	Clear Results Presented	Level of Quality
MacKay (1969)	SS	15 (EXP 1) 8 (EXP 2)	No	Yes	Yes	No	No	No	No	Yes	Low
Macleod et al. (1995)	SS	10 PWS	No	Yes	Yes	Yes	No	Yes	No	Yes	Moderate
Marshall & Neuburger (1987)	SS	3 PWS (males)	No	Yes	Yes	Yes	No	No	Yes	Yes	Low
Pollard et al. (2009)	SS	11 PWS (6 males, 5 females	Yes	Yes	Yes	Yes	Yes	No	No	Yes	Moderate
Ritto et al. (2016)	RCT	18 PWS (16 males, 2 females)	No	Yes	Yes	No	No	Yes	No	Yes	Moderate
Stuart et al. (2008)	Time-series	12 PWS (10 males, 2 females)	No	Yes	Yes	Yes	No	No	Yes	Yes	Moderate
Unger et al. (2012)	SS	30 PWS (23 males, 7 females)	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	High
Van Borsel et al. (2003)	SS	9 PWS (4 males, 5 females)	Yes	Yes	Yes	Yes	No	No	Yes	Yes	Moderate

*Abbreviations: EXP=experiment; PNS=people who do not stutter; PWC=people who clutter; PWS=people who stutter; QE=quasi-experimental; RCT=randomized controlled trial; SS=single-subject

The outcomes discussed are those that directly pertained to the PICO question of this systematic review (note that additional outcomes were measured in some studies). Many of the studies (n = 7) involved only the measurement of stuttering frequency, while other studies reported on other primary outcomes; that is, the authors of four additional studies also measured single outcomes, including speech naturalness (n = 1), number of word errors (n = 1), stuttering probability (n = 1), and stuttering duration (n = 1). The remaining five studies involved the measurement of two or more of the following outcomes per study: stuttering frequency, stuttered intervals, stuttering duration, frequency of stuttering type, speech rate, stutter-free speech rate, and speech naturalness.

The studies examined for this systematic review all assessed the efficacy of AAF in various ways. For instance, Hutchinson and Burk (1973), Marshall and Neuburger (1987), and Van Borsel, Reunes, and Van de Bergh (2003) only assessed DAF. MacKay (1969) also examined DAF, but instead studied the effects of speaking with nasal accent and distortion under DAF. The sole effects of FAF on stuttering were analyzed by Hargrave, Kalinowski, Stuart, Armson, and Jones (1994); Ingham et al. (1997); and Stuart, Frazier, Kalinowski, and Vos (2008). Geetha and colleagues (2017) studied both DAF and FAF and their separate efficacies.

One particular intervention tool, the SpeechEasy® device, was utilized and assessed by Armson and Kiefte (2008); Foundas, Mock, Corey, Golob, and Conture (2013); and Pollard, Ellis, Finan, and Ramig (2009). Ritto, Juste, Stuart, Kalinowski, and Andrade (2016) also examined the SpeechEasy® device but compared its effects to that of a 12-week fluency promotion treatment that includes the use of techniques based on fluency shaping and stuttering modification. The combined effects of DAF and FAF were also studied by Unger, Glück, and Cholewa (2012) using two other commercially available, portable AAF devices. Additionally,

Hudock and Kalinowski (2014) and Lincoln et al. (2010) were interested in similar outcomes and assessed combinations of DAF and FAF effects, but not with commercial devices. Macleod, Kalinowski, Stuart, and Armson (1995) also examined the combination of DAF and FAF (not via a commercial device), but also compared its effects to that of DAF and FAF alone. For a summary of the included studies, see Table 6.

Discussion

Overall Findings

DAF, when used alone, generally reduces frequency of stuttering in its immediate application and is most effective during less structured speaking tasks (Marshall & Neuburger, 1987; Van Borsel et al., 2003). Of the studies within this review assessing only FAF, stuttering frequency and duration were found to be significantly reduced during reading tasks (Hargrave et al., 1994; Stuart et al., 2008); however, one study revealed inconsistent results amongst its four participants, ranging from no response to substantial and sustained improvements in speech performance (Ingham et al., 1997).

Studies assessing the effectiveness of the commercially available SpeechEasy® device showed that stuttering frequency (most evident during reading tasks), speech rate, and speech naturalness were significantly improved when the device was worn (Armson & Kiefte, 2008; Foundas et al., 2013). Interestingly, the severity of an individual's stutter, as well as the use of individual custom device settings, may contribute to the degree of stuttering reduction achieved through the use of the SpeechEasy® (Foundas et al., 2013). Additionally, one study found that use of the device was as effective as a 12-week fluency treatment program in reducing stuttering frequency (Ritto et al., 2016). The efficacy of two additional commercially available devices was

Table 6. Study Characteristics and Results

Authors (Year)	Study Design	Number of Participants	Age Range	Type of Speech Assessed	Outcomes	Measurement	Significant Results	Conclusion (Efficacy)
Armson & Kiefte (2008)	SS	31 PWS (20 males, 11 females)	18-51	R, M (DAF + FAF combo device)	1. ↓ stuttering freq. 2. Speech rate 3. ↑ speech naturalness	1. %SS 2. # syllables/ duration (sec.) 3. Rating scale	1. R vs. M, device use 2. R vs. M, device use 3. Device use	1. Yes 2. Yes 3. Yes
Foundas et al. (2013)	QE	24 males (14 PWS, 10 PNS)	20-46	R. M, C (DAF + FAF combo device)	1. ↓ stuttering freq.	1. # stutters/100 syllables	1. Device use, R task, ear placement (C task), baseline stuttering rate (severity)	1. Yes
Geetha et al. (2017)	QE	50 males (25 PWS, 25 PNS)	18-30	SP (DAF, FAF)	1. Speech naturalness	1. Rating scale	1. Diff. b/w groups (all conditions)	1. No
Hargrave et al. (1994)	SS	14 PWS (12 males, 2 females)	18-52	R (FAF levels)	1. ↓ stuttering freq.	1. %SS	1. FAF levels vs. NAF	1. Yes
Hudock & Kalinowski (2014)	SS	9 PWS (8 males, 1 female)	21-72	R (DAF + FAF combos)	1. ↓ stuttering freq.	1. %SS	1. Combos vs. NAF, COMBO-4 vs. COMBO-2	1. Yes
Hutchinson & Burk (1973)	QE	27 (10 PNS, 9 PWS, 6 PWC, 2 PWS + PWC)	19-23	R (DAF)	1. # word errors	1. Mean value	U/A	1. No
Ingham et al. (1997)	SS	4 PWS (males)	19-35	R, SP (FAF)	1. Stuttered intervals 2. Stutter-free speech rate 3. Speech naturalness	1. # per trial 2. # syllables/ minute 3. Rating scale	U/A	Inconsistent for all

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Authors (Year)	Study Design	Number of Participants	Age Range	Type of Speech Assessed	Outcomes	Measurement	Significant Results	Conclusion (Efficacy)
Lincoln et al. (2010)	SS	11 PWS (7 males, 4 females)	21-65	R, C (DAF + FAF combos)	1. ↓ stuttering freq.	1. %SS	1. NAF (C) vs. combos (group) *not NAF vs. combos (indiv.)	1. No
MacKay (1969) Experiment 1	SS	15	Mean: 26	R (DAF)	1. Stuttering probability (w/ nasal accent)	1. U/A	1. 'Normal' rate vs. fast rate	1. Yes
MacKay (1969) Experiment 2	SS	8	Average: 21	R (DAF)	1. Stuttering probability (w/ nasal distortion)	1. U/A	U/A	1. Yes
Macleod et al. (1995)	SS	10 PWS	21-56	R (DAF, FAF, DAF + FAF combo)	1. ↓ stuttering freq.	1. %SS	1. Both normal and fast speech rates, NAF vs. conditions	1. Yes
Marshall & Neuburger (1987)	SS	3 PWS (males)	39-51	M (DAF)	1. ↓ stuttering freq. 2. Speech rate	1. U/A 2. Words/min.	U/A	1. Yes
Pollard et al. (2009)	SS	11 PWS (6 males, 5 females	18-62	R, C (DAF + FAF combo device)	1. ↓ stuttering freq.	1. %SS	1. Speech task, phase	1. No
Ritto et al. (2016)	RCT	18 PWS (16 males, 2 females)	Group 1: 21-42 Group 2: 20-50	R, M, C (DAF + FAF combo device)	1. ↓ stuttering freq.	1. %SS	1. Testing times (initial, 3 mos., and 6 mos.)	1. Yes
Stuart et al. (2008)	Time-series	12 PWS (10 males, 2 females)	20-50	R (FAF)	1. Stuttering duration	1. Stutters/min.	1. NAF vs. FAF, avg. duration of stuttering types	1. Yes
Unger et al. (2012)	SS	30 PWS (23 males, 7 females)	18-68	R, M, C (DAF + FAF	1. ↓ stuttering freq. 2. Stuttering duration 3. Speech rate	1. %SS group 2. In seconds 3. Syllables/min.	1. NAF vs. combo, all speech tasks, certain severity levels w/	1. Yes 2. No 3. No

				combo, placebo)	4. Freq. stuttering type	4. %SS ind. 5. *SSI-4*	certain speech tasks 4. Blocks vs. other types	4. Yes
Authors (Year)	**Study Design**	**Number of Participants**	**Age Range**	**Type of Speech Assessed**	**Outcomes**	**Measurement**	**Significant Results**	**Conclusion (Efficacy)**
Van Borsel et al. (2003)	SS	9 PWS (4 males, 5 females)	18-45	A, R, M, C, repetition (DAF)	1. ↓ stuttering freq. immediate 2. ↓ stuttering freq. 3 mos. post 3. ↓ stuttering freq. w/ NAF imm. vs. post 4. ↓ stuttering freq. w/ DAF imm. vs. post	1. %stuttered words 2. %stuttered words 3. %stuttered words 4. %stuttered words	1. A, C, M, R, repetition (NAF vs. DAF) 2. R (NAF vs. DAF) 3. A, R, M repetition	1. Yes 2. Yes 3. Yes 4. No

*Abbreviations: A=automatic speech (i.e., counting, reciting days of week and months of year); C=conversation/dialogue; DAF=delayed auditory feedback; FAF=frequency altered feedback; M=monologue; NAF=non-altered auditory feedback; PNS=people who do not stutter; PWC=people who clutter; PWS=people who stutter; QE=quasi-experimental; R=reading aloud; RCT=randomized controlled trial; SP=spontaneous speech; SS=single-subject; U/A=unavailable; %SS=percentage syllables stuttered

assessed, and the results showed that stuttering frequency was significantly reduced during reading tasks and block disfluencies (as opposed to repetitions or prolongations) and that the severity levels of participants' stuttering were correlated to their results during some speaking tasks (Unger et al., 2012).

Non-commercial AAF devices combining DAF and FAF also significantly reduced stuttering frequency during reading tasks, with one study demonstrating the benefit of a specific combination of AAF settings over another (Hudock & Kalinowski, 2014), and one showing that the DAF and FAF combination is not more effective at reducing stuttering than either one alone (Macleod et al., 1995).

Despite the findings supporting the use of AAF in the reduction of stuttering, certain studies showed no significant changes in stuttering frequency and speech naturalness for DAF (Hutchinson & Burk, 1973; Geetha et al., 2017); speech naturalness for FAF (Geetha et al., 2017); stuttering frequency with the SpeechEasy® (Pollard et al., 2009); or stuttering frequency (Lincoln et al., 2010), duration of stuttering events, and speech rate (Unger et al., 2012) for non-commercial AAF combination devices.

The studies analyzed in this systematic review also support findings in the existing literature, including the high variability of AAF, general efficacy of the SpeechEasy® device, and benefit of AAF being most significant during reading tasks. Regarding this review's research question, the studies generally support the effectiveness of AAF devices in the improvement of fluency in adults who stutter, with most benefit noted in stuttering frequency reduction compared to other defining aspects of speech fluency (e.g., speech rate).

Clinical Implications

The study results imply that complete fluency of speech is rarely obtained via AAF use, regardless of altered feedback type, suggesting that AAF devices should be used in conjunction with traditional speech therapy for better results. While speech therapy should be used alongside AAF, the modification of slowed speech rate (traditionally used in stuttering modification therapy) may not be necessary when using AAF devices. If incorporated into therapy, speech-language pathologists should consider the finding that structured speaking tasks may be most suitable for AAF use. While AAF may be used effectively in structured speaking tasks, its effects in real-life communication will not likely be as strong as with structured speaking tasks. Additionally, clients should be counseled when considering AAF implementation, as its benefits are highly variable among individuals.

Limitations

A number of research limitations have been identified within the reviewed articles. Most notably, there is a lack of real-world application of AAF devices, since AAF intervention typically occurs in a very structured clinical setting that is not malleable to spontaneous communication. Additionally, researchers rarely assessed the effect of AAF devices on fluency when applying customized AAF settings tailored to each individual client, which may underestimate the fluency-enhancing properties of AAF.

Future Research

Considerations for future research that would best support gaps within the current literature are manifold. For instance, future research should assess AAF use in clinically meaningful or real-life speaking situations in order to provide information on generalizability of the intervention effects. Furthermore, future research should address the effects that AAF has on

fluency when using individualized custom settings. This could provide informative intervention that is tailored to specific clients. Additionally, future research should examine the effectiveness of AAF when used in conjunction with traditional speech therapy (compared to AAF alone); the long-term effects of device use; whether counseling or training on AAF use affects fluency enhancement; whether factors such as gender or cognitive status influence the efficacy of AAF on fluency enhancement; and whether optimal AAF settings exist regarding DAF, FAF, or the combination of both.

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