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Listener Perceptions of Simulated Fluent Speech in Nonfluent Aphasia

Aphasiology

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Abstract

Background: People with aphasia (PWA) are frequently perceived less favorably by listeners than their peers. These perceptions include incorrect assumptions that can prevent successful social interactions. While communication partner training has been shown to improve social outcomes related to the listener (see e.g., Kagan, Black, Duchan, Simmons-Mackie, & Square, 2001), changing the verbal output of PWA may also yield more favorable listener perceptions about the speech, speaker, and their own affective response. We investigated the effects of artificially altered fluency (i.e., simulated fluency) on listeners' subjective impressions.

Aims: The purpose of the study was to (1) confirm that listeners perceive PWA less favorably than their neurologically healthy peers and (2) determine the effects of simulated fluency on listener perceptions about PWA.

Method & Procedures: Thirty-eight listeners heard nine narrative monologue language samples from three conditions (i.e., speakers with nonfluent aphasia, simulated fluent samples from the same speakers, and neurologically healthy speakers). Listeners responded to a nine-item questionnaire that probed perceptions about speech output, speaker attributes, and listener feelings.

Outcomes & Results: Listeners perceived PWA less favorably than their neurologically healthy peers. Simulated fluency yielded more positive listener perceptions for all questionnaire items except speech intelligibility, which was unchanged by simulated fluency.

Conclusions: Simulated fluency improved listener perceptions of PWA significantly, indicating that speech fluency may be a socially valid treatment target in aphasia. Beyond direct training of communication partners, changing the verbal output of aphasic speech can also yield more positive listener perceptions of PWA.

Keywords: aphasia, communication partners, perception, fluency, environmental factors

Introduction

Listener perceptions play an important role in the communicative interactions of people with aphasia (PWA). Listeners often perceive the speech output and personal attributes of PWA less favorably than their peers (Allard & Williams, 2008; Croteau & Le Dorze, 2001; Zraick & Boone, 1991). Additionally, listeners may perceive themselves as having negative feelings in response to PWA. Communication partner training has shown that listeners can change their perceptions of PWA and contribute to improved communicative interaction (Kagan, Black, Duchan, Simmons-Mackie, & Square, 2001). While directly training the listener is an important way to change societal impressions, listeners' perceptions may also change as PWA modify their speech and language behaviors. Behavioral modification might similarly lead to increased opportunities for successful communicative interactions. The relationship between the speech behavior of PWA and societal impressions, however, has rarely been investigated. The present study examined the impact of digitally altered fluency on listener perceptions of people with nonfluent aphasia.

Perceptions of PWA

PWA are concerned about the way they are perceived by communication partners. In semi-structured interviews, PWA have identified negative perceptions of communication partners as causing them to feel misunderstood and unsupported. These perceptions create barriers to their communicative participation (Le Dorze, Salois-Bellerose, Alepins, Croteau, & Hallé, 2014; Le Dorze & Brassard, 1995). Parr (2001) reported on qualitative interview data from 50 PWA and found that disabling attitudes such as ignorance, prejudice, and pity were among the principal social barriers interviewees described. For example, one PWA commented about being ignored in public places, while another remarked on being deemed an “imbecile” (Parr, 2001, p. 276). Others have observed that being viewed as “stupid” is, in fact, a common fear for many PWA (Kagan, 1998). Such negative perceptions can increase the burden of communication and augment anxiety or apprehension about social interaction. PWA have specifically reported holding back, withdrawing, and even avoiding social situations because they were afraid of being perceived negatively (Le Dorze et al., 2014).

Unfortunately, in accordance with their fears, negative perceptions of PWA seem to be a reality. Previous research clearly suggests that loved ones and the general public perceive PWA, particularly those with nonfluent aphasia, less favorably than their peers. These negative assumptions are not restricted to the speech output but also include negative impressions about the character, personality, and attributes of PWA. Zraick and Boone (1991) compared perceptions among spouses of people with nonfluent aphasia, fluent aphasia, and a control group. Seventy statements were combined into six factors (i.e., maturity, independence, desirability, compliance, egocentricity, and sociability). Spouses of individuals with nonfluent aphasia perceived their spouse more negatively on all factors when compared with spouses of people without aphasia. In addition, people with nonfluent aphasia were perceived as less independent, compliant, and sociable than those with fluent aphasia. Similarly, Croteau and Le Dorze (2001) used an adjective checklist to show that PWA were viewed by their spouse as being more dependent and less likable than people without aphasia. They also found that spouses perceived their partner with aphasia significantly worse in achievement, endurance, and organization. The authors argued that negative spousal perceptions might exacerbate the impairments of PWA. In other words, their abilities may decrease due to diminished spousal expectations associated with negative perceptions.

The personality and attributes of PWA are also perceived less favorably by unfamiliar communication partners. Several studies have documented that unfamiliar communication partners may not be aware of the competence and intelligence of PWA. (Kagan, 1998; Le Dorze et al., 2014; Simmons-Mackie & Damico, 2007; Simmons-Mackie & Elman, 2011). However, the perceptions of unfamiliar communication partners have mostly been reported from the perspective of PWA. One exception is a study conducted by Allard and Williams (2008) in which 445 listeners heard an actor's depiction of Wernicke's aphasia, articulation disorder, stuttering, voice disorder, and no disorder. They found that listeners perceived the Wernicke's aphasia condition as significantly less decisive and reliable, and more anxious than the other four conditions. Although little research is available regarding listeners' perceptions of PWA, less favorable speaker attributes appear to be ascribed to PWA by both familiar and unfamiliar communication partners.

In addition to perceiving the attributes of PWA less favorably than peers without aphasia, listeners also feel uncomfortable interacting with PWA. Lasker and Beukelman (1999) compared listeners' perceptions of story telling by a PWA under three conditions: unaided and using two different modes of augmentative and alternative communication (AAC; i.e., a communication notebook and digitized speech). Similar-aged peer listeners viewed audiovisual recordings of each condition. Mean Likert ratings showed that listeners felt most uncomfortable listening to unaided aphasic speech. The listeners reported that their discomfort was, in part, due to lack of understanding and difficulty fulfilling their role as communication partner.

Listener discomfort may cause people to avoid conversations with PWA. This is evident from both the perspective of PWA and their communication partners. PWA have reported that speaking partners seem to avoid attempting or pursuing conversation with them due to discomfort (Le Dorze et al., 2014). Family members and friends have reported regularly performing communicative tasks such as reading, writing, and answering questions for the PWA (Le Dorze & Brassard, 1995). Discomfort felt by communication partners may limit social interaction for PWA.

Communication partner perceptions regarding speech, speaker attributes, and their own feelings during interaction have important implications for autonomy and identity of PWA. Shadden and Agan (2004) described that fostering values of respect, acceptance, validation, and encouragement were key elements of a stroke support group that aimed to nurture identity. In a qualitative analysis of a group therapy session involving 10 people with aphasia, Simmons-Mackie and Elman (2011) confirmed that respect and an assumption of competence by communication partners marked important aspects of identity renegotiation during group therapy. From these two studies, it appears that fostering positive perceptions of PWA is critical in successfully renegotiating identity.

Perceptions have the potential to change communicative interactions between PWA and their partners. Negative and incorrect perceptions about PWA can promote social isolation and limit opportunity for communicative interaction. Simmons-Mackie and Damico (2007), for example, have suggested that communicative interactions between PWA and their conversation partners can be negatively impacted by inequality and marginalization, which occur when PWA are looked down on. The authors proposed that the solution to these issues includes partners perceiving PWA as competent and able to contribute to an interaction. Because negative perceptions interfere with communication, they have been targeted in communication partner training (Kagan et al., 2001; Kagan, 1998).

Perceptions of communication partners can change with intervention. In communication partner training, partners are taught to successfully converse with PWA (Simmons-Mackie, Raymer, Armstrong, Holland, & Cherney, 2010; Turner & Whitworth, 2006). Training usually includes strategies that partners can integrate into their interactions to improve the communicative exchange and encourage participation (Turner & Whitworth, 2006). One area of emphasis in Supported Conversation for Adults with Aphasia (SCA; Kagan et al., 2001) is acknowledging competence, which includes an assumption of competence as well as attitudes of encouragement, support, and respect. Kagan et al. (2001) found that 17 out of 20 trained volunteers improved in their scores of acknowledging competence during a conversation with PWA. Thus, direct intervention can affect partner communication, which may, in turn, improve their perceptions and overall interactions with PWA.

Speech fluency as a behavior of interest

Another way to improve listener perceptions is to change the speech qualities that trigger negative perceptions in the first place. In the present study, we consider the social outcome of listener perceptions as a function of speech behavior. The behavior selected for manipulation in this study was speech fluency. Based on evidence from the stuttering literature, we speculated that fluency—though rarely targeted directly in aphasia treatment—might have important social impact by moderating listener perceptions about the speaker's competence and personality. We define disfluency herein as any behavior that impedes the forward flow of speech (Van Riper, 1982). Both language and motor speech impairments common in nonfluent aphasia (i.e., anomia, agrammatism, or apraxia of speech) are likely to contribute to disfluent speech production (McNeil & Copland, 2011). For example, poor word retrieval may result in pauses and hesitations, agrammatism might impact rhythm, and difficulties programming motor speech tasks may trigger revisions and repetitions.

Increased speech fluency through simulation has led to improved listener perceptions of people who stutter (Evans, Healey, Kawai, & Rowland, 2008; Panico, Healey, Brouwer, & Susca, 2005; Susca & Healey, 2001). These improvements have been shown across listener perceptions regarding speech output, speaker attributes, and listener feelings in response to stuttered speech (Evans et al., 2008; Lay & Burron, 1968; Panico et al., 2005; Susca & Healey, 2001, 2002; Von Tiling, 2011). Conversely, listeners have made more negative comments about the character traits (i.e., pleasantness, friendliness, confidence, and intelligence) of more disfluent speakers (Susca & Healey, 2002; Von Tiling, 2011). Listeners also perceive themselves as less comfortable, expending more effort, and becoming more impatient while listening to increasingly disfluent speech (Panico et al., 2005; Susca & Healey, 2001, 2002). The impact that speech fluency has on listener perceptions of people who stutter might transfer to other populations such as PWA.

To our knowledge, no study has yet been conducted on how simulated speech fluency of PWA impacts listener perceptions. The purpose of the present study was to (a) confirm the previous literature regarding less favorable listener perceptions of PWA and (b) determine if increasing speech fluency from PWA through digital manipulation affects listener perceptions. Based on the stuttering literature, we postulated that increased fluency would improve listener perceptions of PWA. As a secondary goal we sought to determine whether graduate students who had taken a course about neurogenic communication disorders and undergraduate students differed in their perceptions of PWA. Because communication partner training has been shown to improve behaviors of acknowledging competence (Kagan et al., 2001), we hypothesized that graduate student listeners would perceive PWA more positively than undergraduate listeners.

Method

Participants

Speakers. Audio samples were obtained from nine speakers using the *AphasiaBank* database (http://talkbank.org/AphasiaBank/). These were monologue language samples from the discourse production portion of the *AphasiaBank* protocol for story narrative (AphasiaBank, 2007). Six aphasic speech samples were obtained using the following criteria: Western Aphasia Battery (WAB; Kertesz, 2006) classification of Broca's aphasia, WAB aphasia quotient of greater than 40, and Boston Naming Test short form (Kaplan, Goodglass, & Weintraub, 1983) score of greater than or equal to five (see Table 1). The remaining three *AphasiaBank* samples were from neurologically healthy speakers.

Listeners. Thirty-six adults participated as listeners. Eighteen were undergraduate students (16 females) from the University of North Carolina at Chapel Hill (UNC-CH). They had declared a variety of majors and were between the ages of 18 and 22 (*M* =

19.5). Eighteen were graduate level speech-language pathology (SLP) students (15 females) between the ages of 22 and 40 (*M* = 26.5). Fourteen graduate students and five undergraduate students reported 10 or more hours listening to or working with adults with speech or language problems. In addition, all graduate students had taken at least one semester-long course about adult neurogenic communication disorders.

Listeners were asked to rate nine audio samples from three sample conditions. Ratings were based on listeners' perceptions of the speech, thoughts about the speaker, and feelings associated with listening to the sample.

Procedures

Audio samples. After selection, each of the six aphasic speech samples was modified to create a simulated fluent sample. Information about the audio samples used in the study is summarized in Table 2. The first author followed a procedure used in previous studies (Lay & Burron, 1968; Susca & Healey, 2001) to create simulated fluent samples in Audacity 2.0.5 (Audacity Team, 2013) by deleting pauses greater than 0.4 seconds, fillers, filled pauses, repetitions, and revisions through waveform editing. Repetitions were defined as speech sounds, words, or phrases that were produced immediately before or after the same sound, word, or phrase. Self-corrections and revisions were defined as multiple attempts at a word or phrase that did not fall under the category of a repetition. Pauses (i.e., time lapsed without speech sound production), fillers (e.g., um), and filled pauses (i.e., time lapsed with intermittent fillers) were also deleted. The resulting samples were subsequently judged for naturalness by the first three authors. They rated naturalness independently on a five-point scale (1 = unmodified, 5 = heavily modified). Consensus ratings, based on initial impressions, are listed in Table 2.

Two of the six samples were rated as unmodified, three were rated as equivocally modified, and one was rated as slightly modified. None were rated as moderately or heavily modified. Syllable boundaries were coded automatically using a customized syllable identification routine implemented in Praat to obtain the number of syllables produced in each sample (Boersma & Weenink, 2014; de Jong & Wempe, 2009; Haley, Jacks, Riesthal, Abou-khalil, & Roth, 2015). Automated syllable coding then was checked manually by research assistants before calculating the speech rate (i.e., syllables per second) for each sample. We used speech rate as a proxy measure for speech fluency, but did not count specific disfluent behaviors or percentage of disfluencies, as the reliability of coding for these is often limited (e.g. Curlee, 1981). The speech rate for the simulated fluent samples was, on average, 2.49 syllables per second greater than the speech rate for the aphasic speech samples. The mean duration of the aphasic speech, simulated fluent, and neurologically healthy samples were 6 min 19 s (*SD* = 3 min 8 s), 1 min 47 s (*SD* = 51 s), and 2 min 9 s (*SD* = 1 min 21 s) respectively. Figure 1 shows a spectrogram of a paired portion of the aphasic speech and simulated fluent samples for P01.

For listening purposes, the speech samples were partitioned into two groups so that no listener could hear the same speaker with aphasia under both the unmodified and simulated fluency conditions. If a speaker’s unmodified speech sample appeared in group A, his/her simulated fluent speech sample had to appear in group B, and vice versa. All listeners heard three samples of unmodified aphasic speech, three samples of simulated fluent speech, and the same speech samples of the neurologically healthy speakers (see Table 2, “Listener Group” column). To keep the listeners blind to the experimental manipulation, they were not informed about the editing or modification of the aphasic speech samples.

Questionnaire. The questionnaire consisted of nine seven-point Likert statements (ranging from strongly disagree to strongly agree). The nine statements were formulated based on adaptation of similar questionnaires used in the stuttering literature (Evans et al., 2008; Panico et al., 2005; Susca & Healey, 2001). The statements were divided into three categories (i.e., speech output, speaker attributes, listener feelings) to measure various aspects of listener perception. As previously explained, listener perceptions are not confined to impressions about speech behavior per se, but also encompass thoughts about the personality and characteristics of the speaker and feelings that listeners experience in response to speech (Ostrom, 1969). Separation of the statements into the three categories followed a procedure used by Evans et al. (2008) who divided individual Likert statements into behavioral (pertaining to the *speech*), cognitive (pertaining to *thoughts* about the speaker), and affective (pertaining to *feelings*) perceptual responses. The nine declarations included two concerning speech output (Sp), four about speaker attributes (SA), and three regarding listener feelings (LF). The nine statements were:

1. I would feel comfortable having a conversation with this person. (LF)
2. This person’s speech made me feel impatient. (LF)
3. I felt like listening to this person speak took a lot of effort. (LF)
4. This person told the story easily. (Sp)
5. I think this person is intelligent. (SA)
6. I think this person lacks confidence. (SA)
7. I think this person is a competent speaker. (SA)

8. This person's speech was hard to understand. (Sp)
9. I think this person would have a hard time making friends. (SA)

Three open-ended questions were also included in the questionnaire to probe qualitative aspects of the listeners' perceptions. Responses from open-ended questions are not reported in this study.

Data collection. Listening sessions occurred individually (12 listeners) or in groups ranging in size from two to six people (24 listeners). All sessions took place on the UNC-CH campus in a quiet room behind closed doors. Sessions were randomly assigned to either sample group A or B. The order of sample presentation was randomized for each of these groups. Although all listeners during group sessions listened to the same sample group, an equal number of graduate and undergraduate student listeners heard the same samples in the same order. The audio samples were presented in a sound field over PC speakers. To ensure a comfortable intensity level, listeners were given control of adjusting the speaker volume throughout the session. In the group listening sessions, one listener was assigned volume control for the group.

During the session, participants were each sent an online survey link to their personal email account. They each responded to the survey items on a personal laptop or laboratory computer. They were instructed to respond independently and refrain from talking throughout the session. The first author was present at each listening session to provide instructions and ensure that no discussion took place between listeners.

Listeners responded to nine Likert statements, presented in randomized order, immediately following the presentation of each sample. In other words, listeners heard a sample, rated their perceptions of that sample, then repeated the process for a different speaker. Each listener or group heard each of the nine samples once. When a listening session occurred in a group, all listened to the same sample simultaneously then provided individual responses to Likert statements. Upon completing the listening session the listeners were asked to keep details of the experiment confidential in order to avoid biasing the responses of future participants. Prior to data analysis, scores from all negatively worded Likert statements were inverted so higher scores would represent more positive perceptions across all questions.

Design and Statistical Analysis

The design of the present study can be conceived as a complex factorial design with both crossed and nested factors. As shown in Table 3, the design included within group factors for Aphasia (i.e., whether the sample was from an Aphasic or Non-aphasic speaker), Fluency (i.e., whether samples from speakers with aphasia were Modified or Unmodified), and Speaker (i.e., individual speakers that produced each sample). The Fluency factor was nested within the Aphasia factor. Thus, unmodified aphasic speech samples were coded as Aphasic-Unmodified, simulated fluent samples were coded as Aphasic-Modified, and samples from neurologically healthy speakers were coded as Non-aphasic. Individual speakers were nested within each of these sample conditions. As noted above, the modified and unmodified speech samples were divided into two Sample Groups (A, B) containing three samples from each condition. If speaker P01's unmodified speech sample appeared in Sample Group A, his or her modified speech sample (P01*) would appear in Sample Group B, and vice versa (see Table 3). This prevented any listener from hearing both the unmodified and modified speech samples of any speaker. As also shown in Table 3, the within group factors were crossed with a between group factor for Listener Group (Undergraduate, Graduate).

Listener ratings were analyzed using a mixed effects ANOVA model. Dependent variables included Likert scores for each individual question and an overall composite (average) of the nine questions. A mixed effects ANOVA model was especially appropriate in the present application because it allowed for both estimation of the same error terms as a conventional repeated measures ANOVA and estimation of additional sources of heterogeneity associated with speakers. Mixed effects models also allow for estimation of fixed effects such as those associated with Aphasia, Fluency, and Listener Group. It should be noted that, due to nesting, we can only uniquely estimate the nested effect of the Fluency factor and not a Fluency by Aphasia interaction.

In the present design, we distinguish between the primary effects of interest, and secondary effects associated with individual speaker differences. The secondary effects included any estimable terms, including interactions, involving the Speaker factor. Because individual differences among speakers are naturally expected and because the purpose of the present study was not to determine the effects of different speakers on listener perceptions but rather the effects of aphasia and simulated fluency, we included these terms in all models, but treated them as statistical nuisance parameters. That is, they were treated as effects that must be included in statistical models in order to obtain unbiased estimates of the primary effects of interest but are not of inherent interest themselves. Although space and parsimony preclude reporting the secondary effects in detail, we note that numerous speaker effects were observed.

The primary effects of interest in this study were ones involving Aphasia, Fluency, Listener Group, and interactions of Aphasia by Listener Group and Fluency by

Listener Group. This model was reduced to find the most parsimonious model for each of the ten dependent variables, but for completeness, we report results based on the full model (see Table 4).

Following mixed effects model analyses, least squares means tests (i.e., marginal means) were completed for follow up on statistically significant 2-way interaction effects. All analyses to test assumptions and visualize the data were conducted using R version 3.0.2 (R Core Team, 2014). Mixed effects models and least squares means follow up analyses were completed with SAS version 9.2. The alpha level was set at .05 for all tests.

Handling of missing data. Fifteen missing values were noted in the dataset due to item nonresponse. These values were replaced by multiple imputation using predictive mean matching (Schenker & Taylor, 1996). Imputation has been shown to be appropriate for item nonresponse in survey data (Brick & Kalton, 1996).

Results

The results of this study show a large impact of aphasia and fluency modification on listener responses to a variety of questions pertaining to speech output, speaker attributes, and listener feelings. Specifically, neurologically healthy speakers received more positive ratings than speakers with aphasia, and aphasic speech samples that were modified to simulate greater fluency were rated more favorably than speech samples that were unmodified (i.e. less fluent; see Figure 2).

The results for the nine individual questions largely mirrored the overall average, with some minor variations. Therefore, we begin by describing the results for the rating composite and then describe differences among the questions. The questions are grouped by conceptual category (i.e., speech output, speaker attributes, and listener feelings). When we refer to a Fluency effect in the results or discussion, it always refers to the effect of Fluency nested within the Aphasia condition.

Overall Ratings

The bar graphs in Figure 2 show mean Likert ratings across three conditions (i.e., aphasic speech, simulated fluency, and neurologically healthy) for each individual question and their overall average. A separate graph is shown for undergraduate and graduate student listener responses. High ratings indicate more positive perceptions. The highest listener ratings were observed for neurologically healthy speakers, followed by simulated fluent speech of PWA, while lowest ratings were found for unmodified samples of PWA. The difference between the sample conditions was statistically robust, with highly significant effects for the Aphasia and Fluency factors ($p < .001$). The main effect of Listener Group and the Fluency by Listener Group interaction were not statistically significant, but the Aphasia by Listener Group interaction was significant, F (1, 34) = 7.50, $p = .01$. Although both listener groups rated samples from PWA less favorably than those from neurologically healthy individuals, differences between the group's ratings of PWA approached significance ($p = .059$), indicating that graduate students perceived aphasic speech samples more favorably than did undergraduate student listeners (see Figure 3).

Speech Output Ratings

In this section we will focus on Likert Ratings of the speech output. The statements related to speech output probed listener perceptions of speech intelligibility and ease of story telling. Figure 2 illustrates the average undergraduate and graduate listener responses for these two statements. Table 4 reports the *F* statistic and significance for all main and interaction effects related to these two statements.

Aphasia. A statistically significant main effect for Aphasia was found for both questions related to the speech output. PWA were rated less favorably than neurologically healthy speakers on both ease of storytelling, F (1, 34) = 1617.03, $p <$ .001, and speech intelligibility, F (1, 34) = 734.51, $p < .001$.

Simulated fluency. Simulated fluency yielded more positive perceptions of the ease with which PWA retold the story, as measured by the Fluency effect, F (1, 34) = 128.48, $p < .001$. However, simulated fluency had no effect on listeners' ratings of speech intelligibility, F (1, 34) = .03, $p = .86$.

Listener group. The main effect for Listener Group was non-significant for both statements about speech output. The Aphasia by Listener Group interaction was statistically significant for speech intelligibility, F (1, 34) = 4.36, $p = .04$. Follow up analyses revealed that graduate student listeners rated speech intelligibility of PWA higher than undergraduate listeners ($p = .048$), whereas no difference was found between groups for non-aphasic samples. Figure 3 illustrates these differences.

Speaker Attribute Ratings

The Likert statements regarding speaker attributes dealt with listeners' thoughts about the intelligence, confidence, communicative competence, and friendliness of the speaker. The average ratings that undergraduate and graduate student listeners assigned for these four statements are represented in Figure 2. Table 4 reports all main and interaction effects related to these four statements.

Aphasia. The main effect for Aphasia was statistically significant for all questions referring to speaker attributes. Listeners perceived PWA as less intelligent, $F(1, 34) = 330.51$, $p < .001$, confident, $F(1, 34) = 170.34$, $p < .001$, competent, $F(1, 34) = 1212.76$, $p < .001$, and friendly, $F(1, 34) = 394.85$, $p < .001$, than neurologically healthy speakers.

Simulated fluency. The effect of simulated fluency was also statistically significant for all speaker attribute ratings. Simulated fluency led to more positive perceptions of speaker intelligence, $F(1, 34) = 5.48$, $p = .03$, confidence, $F(1, 34) = 66.81$, $p < .001$, communicative competence, $F(1, 34) = 31.56$, $p < .001$, and friendliness, $F(1, 34) = 20.35$, $p < .001$. There was no interaction among speaker attribute ratings, indicating that the effect of simulated fluency on improving listener perceptions of speaker attributes was independent of listener group.

Listener group. The Listener Group main effect was non-significant for all statements about speaker attributes. Only ratings of speaker intelligence showed a statistically significant Aphasia by Listener Group interaction effect, $F(1, 34) = 13.32$, $p < .001$. Follow up analyses revealed significantly higher ratings of speaker intelligence from graduate compared with undergraduate student listeners ($p = .006$). This difference is illustrated with a boxplot in Figure 3. No difference in speaker intelligence ratings was found between listener groups for non-aphasic samples.

Listener Feeling Ratings

The perceptions that listeners had about their own affective response to the samples were measured through statements about listeners’ feelings of comfort, patience, and effort. Responses for these three statements can be visualized in Figure 2. Main and interaction effects associated with these three statements are reported in Table 4.

Aphasia. The Aphasia main effect was statistically significant for all questions referring to listener feelings. Listeners felt less comfortable, F (1, 34) = 573.47, p < .001, patient, F (1, 34) = 491.07, p < .001, and felt like they exerted more effort, F (1, 34) = 850.75, p < .001, while listening to PWA compared with neurologically healthy speakers.

Simulated fluency. The effect of simulated fluency was statistically robust for all ratings related to listener feelings. Listeners reported feeling significantly more comfortable, F (1, 34) = 17.89, p < .001, patient, F (1, 34) = 141.09, p < .001, and having to exert less effort, F (1, 34) = 37.16, p < .001. Fluency by Listener Group interactions were non-significant for all questions pertaining to listener feelings. Thus, the effect of simulated fluency on listener feelings was consistent between listener groups.

Listener group. No significant Listener Group main effects were found for ratings of listener feelings. Aphasia by Listener Group interactions were non-significant for all statements except the one regarding listener comfort, F (1, 34) = 16.96, p = < .001. Consistent with all other Aphasia by Listener Group interactions heretofore reported, follow up analyses revealed higher ratings of comfort from graduate SLP students while listening to PWA (p < .001) but no difference between group ratings while listening to neurologically healthy speakers (see Figure 3).

Discussion

Findings from this study indicate that (a) samples from PWA yield less favorable listener perceptions of the speech, speaker, and listener feelings than samples from neurologically healthy individuals; (b) graduate student listeners perceive PWA as more intelligible, intelligent, and comfortable to listen to than do undergraduate student listeners; and (c) simulated fluency of aphasic speech positively impacts listener ratings of speech, speaker, and listener feelings. We will discuss each of these findings separately. We will then suggest several clinical implications.

Negative Perceptions of PWA

The first purpose of the present study was to confirm previous reports that listeners perceive PWA less favorably than neurologically healthy adults. Listeners in this study reported less favorable perceptions of PWA across ratings about speech output, speaker attributes, and listener feelings. Negative listener perceptions of PWA may contribute to decreased life participation and ultimately lead to social isolation (Gillespie, Murphy, & Place, 2010; Shadden & Agan, 2004). Professionals have been called upon to help communication partners of PWA change their perceptions to increase opportunities for social interaction (e.g., Kagan, 1998; Simmons-Mackie & Damico, 2007). The present data strongly support this appeal. They also confirm fears often expressed by PWA: being perceived as having compromised intelligence and competence (Kagan, 1998; Parr, 2001). Education and training can help change the public view of aphasia and overcome this stigmatization.

Graduate Student Perceptions of PWA

Graduate student listeners perceived the speech of PWA as more intelligible and PWA as more intelligent and comfortable to listen to than did undergraduate student listeners. Graduate students had been educated about aphasia and exposed to adults with communication disorders. They likely showed less difficulty understanding PWA because they were equipped with strategies derived from experience. Although exposure to PWA alone has shown minimal effects on conversational partners’ ability to acknowledge and reveal competence (Kagan et al., 2001), the graduate student listeners in this study had a combination of education and clinical experience. It seems that education combined with experience leads listeners to recognize PWA as intelligent individuals and be more comfortable listening to them.

Future studies about listener perceptions should account for factors related to listener sex and age. The listeners represented a younger age range than might typically interact with PWA. In addition, an unequal number of male and female listeners were represented. These considerations may limit the generalization of these findings.

Improved Perceptions of PWA with Simulated Fluency

Our second purpose was to determine the effect of simulated fluency on listener perceptions of PWA. Simulated fluency significantly improved perceptions of listener comfort, listener patience, listener effort, ease of story telling, speaker confidence, speaker communicative competence, and speaker friendliness regardless of listener group. These findings are consistent with previous reports in the stuttering literature. Susca and Healey (2001, 2002), for example, used similar methods to remove disfluencies (i.e., part-word repetitions, whole-word repetitions, phrase repetitions, prolongations, and pauses) from the speech sample of a person who stuttered. They found that listeners' perceptual ratings were generally more favorable as fluency increased. In the present study, aphasic speech samples were modified to create fluent versions of the narrative while maintaining other common aphasic speech behaviors (e.g., sound distortions, agrammatisms, paraphasias), showing that listener perceptions improved as a function of fluency even when other disordered speech and language behaviors remained unchanged. These improvements were found across a variety of questions related to speech output, speaker attributes, and listener feelings.

Simulated fluency improved listeners' perception of how easy it is for PWA to communicate through a story retell task. This result could potentially be an artifact of differing story lengths, as the modified samples were, on average, more than four minutes shorter than the original samples. It may also be that listeners' feelings (i.e., comfort, patience, and effort) influence their perception of how easily the speaker tells the story. Thus, if listeners' emotional reaction to the speech improves, we might expect them to perceive the story as being told more easily. In addition to the nine Likert statements, three open-ended questions were asked of listeners, which may add insight into qualitative aspects of their ratings. Future exploration and report will include qualitative analysis of these responses.

It is notable that no significant difference was found in listeners' perception of intelligibility for simulated fluent compared with aphasic speech samples. Because the simulated fluent samples contained the same sound and word productions as the paired aphasic speech sample we would not expect intelligibility to improve per se. The contrast between ease of story-telling and speech intelligibility seems to appropriately pinpoint the importance of considering social variables such as listener perceptions. Increasing speech fluency may not improve how well the speech of PWA is understood, though it may improve how PWA are perceived and increase their opportunities for communicative interaction.

Speakers from simulated fluent samples were perceived as more confident, competent, and friendly. This is particularly important given that listener acknowledgement of competence when communicating with PWA is thought to have a significant impact on communicative interactions (Kagan et al., 2001; Kagan, 1998).

Perceptions of competence and intelligence also highlight an area of direct concern for many people with aphasia during real-world interactions (Kagan, 1998; Le Dorze et al., 2014; Parr, 2001). PWA who are viewed as more competent, confident, and friendly will likely receive and take advantage of more opportunities for social interaction. Of note is the wording of the question regarding competence, which was a rating of competence as a speaker and not competence as a person. It is possible that listeners' responses to the question regarding competence might have been different had they been asked about the person's general competence rather than communicative competence.

Listeners felt more comfortable, patient, and expended less effort listening to simulated fluent speech compared with unmodified aphasic speech. This is consistent with findings from Lasker and Beukelman (1999), who found that peer listeners (i.e., older adults over age 60) reported a greater level of comfort with shorter message duration. Decreased comfort, patience, and effort felt by the listener may restrict their interaction with PWA. Due to its impact on the self-reported affective response of listeners, increased fluency may yield more favorable and more numerous social interactions.

We acknowledge that simulated fluency is not the same as fluent speech produced naturally by PWA. Digital manipulation of speech is useful because it allows us to glimpse possible outcomes of therapeutic targets—in this case, improved speech fluency—without providing treatment. Because disfluent verbal output may be the result of a variety of aphasic impairments, treatments that increase speech fluency might simultaneously impact other impaired behaviors. On the other hand, treatments that target behaviors such as naming and grammatical encoding might also affect speech fluency—

both positively and negatively. One of the strengths of this study is the robust effect of speech fluency on listener perceptions.

Clinical Implications

Findings from this study suggest several clinical applications related to (a) targeting speech fluency and evaluating social treatment outcomes, (b) targeting conversation partners' perceptions through direct training, and (c) using simulated fluency in treatment.

This study showed that speech fluency of PWA affects listener perceptions. Fluency is a viable treatment target for PWA that has been manipulated successfully via script training and choral speech (Fridriksson et al., 2012; Goldberg, Haley, & Jacks, 2012; Youmans et al., 2005; Youmans, Youmans, & Hancock, 2011). Additional research from our laboratory has shown promising results for increasing fluency in PWA using masked auditory feedback (Jacks & Haley, 2014). In particular, we have found that some people with aphasia and/or apraxia of speech increase their rate of speech and decrease disfluencies while listening to noise. While these results have been achieved in a controlled laboratory setting and over a limited period of time, the technique has the potential to achieve lasting gains in combination with behavioral treatment. The outcomes of increased speech fluency extend beyond behavioral change alone and include important social outcomes (i.e., improved listener perceptions) that should not be ignored. This study, therefore, supports speech fluency as a socially valid treatment target.

Treatment targets in general should be evaluated by a combination of behavioral and social impact. Social outcomes have most often been associated with approaches that seek to support communication for PWA by creating environmental facilitators (e.g., conversation partner training). It is less common for approaches that target speech behavior of PWA (e.g., impairment-based approaches) to emphasize social outcomes. Although not a treatment study, this research showed that digitally altered speech behavior has significant impact on listener perceptions, suggesting that targeting behavior can also improve the social environment.

Social outcomes are often overlooked because they can be difficult to measure (Kagan et al., 2001). In this study we successfully measured listener perceptions as an effect of changed speech behavior. Measurement of societal impressions could reasonably be included as an outcome in future intervention studies. Given the plethora of treatment approaches, strategies, and techniques for aphasia intervention, endorsement of treatment methods should move beyond those that merely show behavioral change to those whose targeted behavioral change might have the greatest social impact.

Targeting conversation partners' perceptions through direct training is also important. This study found a clear disparity between listeners' perceptions of PWA and their neurologically healthy peers. It also found that graduate student listeners perceived PWA more positively in some respects than undergraduate students. Communication partner training is a form of evidence-based treatment that often includes work on improving perceptions by directly training the communication partners of PWA (Turner & Whitworth, 2006). For example, one partner training program (Supporting Partners of People with Aphasia in Relationships and Conversations; Lock et al., 2001) gives special attention to targets that trigger negative communication partner responses and another (Supported Conversations for Adults with Aphasia; Kagan et al., 2001) trains partners to acknowledge the competence of PWA by demonstrating an attitude of support, encouragement, and patience. Improving listeners' perceptions of PWA through direct education and training of communication partners should continue to be addressed. Communication partner training could include education about the impact of disfluencies on perceptions and training of specific attitudes that help communication partners tolerate disfluencies (e.g., patience, waiting, listening).

Simulated fluency of aphasic speech might also be used in intervention for treatments targeting behavior and personal identity. For example, a simulated fluent sample could act as a means of self-cueing for repetition-based treatments such as script training (Cherney, Halper, Holland, & Cole, 2008; Lee, Kaye, & Cherney, 2009). Rather than repeating another person's productions, a simulated fluent sample would allow PWA to be their own model, potentially increasing autonomy and motivation for these interventions. In addition to using simulated fluency to target speech behavior, simulated fluency might be a useful tool for enhancing the personal identity of PWA. Findings from this study indicate that listeners' judgments about the personality and attributes of PWA become more positive when the speech of PWA is made more fluent. While more favorable listener perceptions are likely to aid in establishing a more positive social identity, it would also be interesting to learn if hearing simulated fluent samples of their own speech improves self-perceptions of PWA. It seems obvious that people would think they sound better when made more fluent—for example, PWA have shown improved self-ratings of their speech following an increased speaking rate (Youmans et al., 2011)—but would PWA also have more positive perceptions of their own ability to produce speech successfully? Would they view themselves more positively? Improving the compromised self-concept and personal identity of PWA is essential (Shadden, 2005). If simulated fluency led to more positive self-perception it might be used as a tool to support confidence and better conceptualize the personal outcomes of speech production training. It is possible that PWA have to actually speak more fluently to enjoy gains in self-concept rather than simply hearing themselves as more fluent, however this is a question that is yet to be studied. Future research should investigate the effects of simulated fluency on self-perceptions of PWA and probe its effect on self-concept and personal identity.

Conclusion

We have learned from the current study that greater fluency is associated with more positive listener perceptions of PWA. These findings, however, should be interpreted with caution. While simulated fluency led to improved listener perceptions, samples were not controlled for duration. It is possible that part of the effect of simulated fluency on listener perceptions was due to sample duration. Future studies could control for the effect of sample duration. Future research should also expand this work by considering motivation and self-perception of PWA in response to simulated fluent speech as well as the utility of simulated fluency to act as a self-cueing mechanism for PWA. There is a need to investigate the social impact of various impairment-based interventions within the field of aphasiology. Increased speech fluency is one behavior that has been shown to improve listener perceptions of people with nonfluent aphasia.

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Tables

Table 1. Demographics and clinical test scores from the nine speaker participants

Speaker	Sex	Age	BNT	WAB Fluency	WAB Aphasia Quotient	WAB Classification
P01	F	69.9	6	2	63.9	Broca
P02	M	66.2	8	4	77.6	Broca
P03	F	54.7	8	4	59.4	Broca
P04	M	41.9	9	4	70.1	Broca
P05	F	53.9	5	4	40.9	Broca
P06	M	54.9	11	4	72.2	Broca
P07	F	75.6	NA	NA	NA	Control
P08	M	41.0	NA	NA	NA	Control
P09	F	61.3	NA	NA	NA	Control

Note. BNT = Boston Naming Test (Kaplan, Goodglass, & Weintraub, 1983); WAB = Western Aphasia Battery Revised (Kertesz, 2006).

Table 2. Audio Sample Information

Speaker		Sample Group	Naturalness Rating	Sample Length	Speech Rate
P01	Aphasic Speech	B	1	2:58	1.07
	Simulated Fluency	A	2	0:52	2.30
P02	Aphasic Speech	B	1	10:12	0.60
	Simulated Fluency	A	1	2:40	1.08
P03	Aphasic Speech	B	1	3:36	1.33
	Simulated Fluency	A	2	1:32	2.28
P04	Aphasic Speech	A	1	6:42	0.47
	Simulated Fluency	B	3	1:08	2.00
P05	Aphasic Speech	A	1	4:38	0.75
	Simulated Fluency	B	1	1:33	1.71
P06	Aphasic Speech	A	1	9:51	1.05
	Simulated Fluency	B	2	3:00	2.86
P07	Neurologically Healthy	A, B	NA	0:42	3.49
P08	Neurologically Healthy	A, B	NA	2:25	4.41
P09	Neurologically Healthy	A, B	NA	3:22	3.05

Note. Naturalness ratings were provided on the following scale: 1 = unmodified; 2 = equivocally/questionably modified; 3 = slightly modified; 4 = moderately modified; 5 = heavily modified. Sample length is represented in minutes and seconds (MM:SS). Speech rate represents syllables per second.

Table 3. Complex Factorial Design for Statistical Analysis.

			Within Group Factors		
			Aphasia Factor		
			Aphasic		Non-aphasic
			Fluency Factor		
			Fluency Unmodified	Fluency Modified	
			Speakers	Speakers	Speakers
Between Group Factor	Undergraduate Student Listeners	Group A	P04, P05, P06	P01*, P02*, P03*	P07, P08, P09
		Group B	P01, P02, P03	P04*, P05*, P06*	P07, P08, P09
	Graduate Student Listeners	Group A	P04, P05, P06	P01*, P02*, P03*	P07, P08, P09
		Group B	P01, P02, P03	P04*, P05*, P06*	P07, P08, P09

Note. * indicates simulated fluent speech.

Table 4. Fixed Effects from Mixed Effects Model.

	Total Average	Speech Intelligibility	Ease of Storytelling	Speaker Intelligence	Speaker Communicative Competence	Speaker Confidence	Speaker Friendliness	Listener Comfort	Listener Patience	Listener Effort
Aphasia	1807.16***	734.51***	1617.03***	330.51***	1212.76***	170.34***	394.85***	573.47***	491.07***	850.75***
Fluency	101.93***	0.03	128.48***	5.48*	31.56***	66.81***	20.35***	17.89***	141.09***	37.16***
Listener Group	0.59	1.13	0.15	2.77	1.11	0.37	2.19	3.99	1.40	0.04
Aphasia by LG	7.50**	4.36*	1.45	13.32***	3.53	0.26	1.07	16.96***	3.98	0.38
Fluency by LG	0.03	0.00	0.20	0.77	0.09	0.05	2.89	0.20	0.04	1.71

Note: LG = Listener Group; *p < .05. **p < .01. ***p < .001.

Figure Caption

Figure 1. Visual depiction of matched portions of aphasic speech and simulated fluent samples in Praat (Boersma & Weenink, 2014) for participant P01. The top spectrogram and waveform shows a portion of the aphasic speech sample (30.37s). The bottom spectrogram and waveform show the matched portion with fluencies deleted (6.47s)—the simulated fluent sample.

Figure 2. Mean Likert ratings of three audio sample conditions by undergraduate and graduate student listeners for all dependent variables. Higher ratings indicate more positive perceptions.

Figure 3. Aphasia by Listener Group interactions. This figure shows box-and-whisker plots of the average Likert ratings for all dependent variables with statistically significant Aphasia by Listener Group interaction effects. The plots illustrate the medians and interquartile range with whiskers extending to 1.5 times the interquartile range. AS = aphasic speech; SF = simulated fluency; NH = neurologically healthy. Undergrad = undergraduate student listener group; Grad = graduate student listener group.