Speech Outcomes for Partial Glossectomy Surgery: Measures of speech articulation and listener perception

Indicateurs de la parole pour une glossectomie partielle : Mesures de l'articulation de la parole et de la perception des auditeurs

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Abstract

The speech characteristics of speakers with partial tongue resections can be variable and are still not well understood. The present study had the goal of investigating the relationship between speech outcome measures, such as the number of consonant sounds distorted, and the impression of naïve listeners, as expressed with a measure of speech acceptability and ratings of social perception. Twenty-two patients with partial glossectomies underwent a speech acceptability rating, an articulation screening, and a social perception rating by five naïve listeners. The results demonstrated a discrepancy between the number of consonant distortions and the assessment of speech acceptability. Speech acceptability appeared to be the more sensitive measure of the altered nature of the patients' speech. Pre-surgical speech acceptability accounted for 63.3% of the variance of the post-surgical speech acceptability, while the amount of tissue resected predicted 41% of the variance. When both measures were combined, the cumulative predictive value increased to 74.2%. A defect size of more than 20.4% tongue tissue was identified as the critical cut-off for poorer speech acceptability. The research also demonstrated that while listeners rated the patients' speech as less acceptable after the surgery, the rated social perceptions of the speakers did not change.

Abrégé

Les caractéristiques de la parole des locuteurs ayant subi une exérèse partielle de la langue peuvent varier et sont encore mal comprises. La présente étude vise à examiner le lien entre les indicateurs de résultats de la parole, comme le nombre de sons de consonnes distordus, et l'impression d'auditeurs, mesurée en fonction du niveau d'acceptabilité de la parole et de la perception sociale. Cinq auditeurs ont évalué la parole de 22 patients ayant subi une glossectomie partielle au plan de l'acceptabilité de la parole, de l'articulation et de la perception sociale. Les résultats montrent un écart entre le nombre de distorsions de consonnes et l'évaluation de l'acceptabilité de la parole. La mesure de l'acceptabilité de la parole semble plus sensible à la nature altérée de la parole des patients. L'acceptabilité de la parole pré-opératoire compte pour 63,3 % de la variation de l'acceptabilité de la parole post-opératoire, tandis que la quantité de tissu résectée prédisait 41 % de la variation. Une fois les deux mesures combinées, la valeur prédictive cumulative a progressé à 74,2 %. On a déterminé qu'une exérèse représentant plus de 20,4 % du tissu de la langue constituait la limite critique du niveau d'acceptabilité de la parole déficitaire. La recherche montre aussi que, même si les auditeurs ont évalué la parole des patients comme étant moins acceptable après la chirurgie, l'évaluation de leur perception sociale n'a pas changé.

Key words: glossectomy, tongue cancer, speech, speech acceptability, social perception, head and neck cancer

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A partial glossectomy is the main treatment approach for cancer of the tongue or floor of the mouth. The tumour is removed *in toto* and the resulting defect is closed locally or with a flap (Rogers, 2001; Logemann, 1994). Research has shown that speech outcomes can be a major determinant of the patient's postoperative quality of life (Radford, Woods, Lowe, & Rogers, 2004). However, the surgical variables that determine postoperative speech and tongue function are not completely understood and neither are the specific characteristics of glossectomy speech (Matsui, Shirota, Yamashita, & Ohno, 2009; Bressmann, Sader, Whitehill, & Samman, 2004; Beck et al., 1998).

Researchers have argued that the extent of the resection (Rentschler & Mann, 1980; Pauloski et al., 1998), the defect site (Logemann et al., 1993; Michiwaki, Schmelzeisen, Hacki, & Michi, 1993), and the reconstruction method for the defect (Konstantinovic & Dimic, 1998) are the crucial factors determining the postoperative speech outcomes. There also has been discussion whether the residual tongue should be kept flexible, at the price of reducing it in volume (Imai & Michi, 1992), or whether bulky, convex flaps should be used to replace lost tissue (Matsui et al., 2009; Yanai et al., 2008; Kimata et al., 2003).

Pauloski et al. (1998) assessed the speech of 142 partial glossectomy patients and found that the extent of the resection correlated with the decrease in articulatory precision. Flap reconstructions lead to poorer outcomes than local closures but the defects that were closed with flaps were larger than those closed locally. Unfortunately, the patients' speech results were not reported in detail in this study. Rather, the results were presented as a series of correlation analyses, relating summarized speech outcomes to different surgical variables. Nicoletti et al. (2004) used an automated speech-analyzer to assess the production of select fricative sounds, such as /s/, /ʃ/, /f/, and /θ/, in 196 patients. The results from the automatic analyzer were combined with a general measure of speech acceptability ("conversational understandability"). The results demonstrated that larger resections lead to poorer speech results. Local reconstructions lead to better results than flap reconstructions when the group was analyzed as a whole, but comparisons in location subgroups failed to differentiate between reconstructive techniques.

The above review of the literature may serve to demonstrate that research on glossectomy speech tends to focus on the surgical technique, rather than the nature of the speech outcomes. However, for speech pathologists, it is important to gain a better understanding of the patterns of glossectomy speech and the impact that these may have on a listener. Thus, the first goal of the present investigation was to examine the relationship between speech outcome measures, such as the number of consonant sounds distorted, and the general impression of naïve listeners, as expressed with a measure of speech acceptability. The second goal of the study was to investigate the impact of the speech disorder on the social perception of the patients' speech by naïve listeners. While it has been shown that speech outcomes are an important determinant of the patient's postoperative quality of life (Radford et al., 2004), there has been very little research on the social perception of glossectomy speech. Rieger et al. (2006) used rating scales with different attributes (e.g., intelligent, employable, drunk, weak, etc.) to quantify listeners' social perceptions of oropharyngeal cancer patients with hypernasal resonance disorders. The authors demonstrated that the postoperative social perception of the hypernasal speakers deteriorated. Turcotte, Wilson, Harris, Seikaly, and Rieger (2009) used a similar method to demonstrate that laryngectomy patients treated with radiation therapy had more favourable social perception scores than patients treated with surgery. The third goal of the study was to delineate the critical defect size after which patients can no longer compensate and their speech acceptability deteriorates. The literature on glossectomy speech suggests that a loss of lingual tissue will interfere with the normal movement of the tongue and result in a reduced range of movement (Pauloski et al., 1998; Nicoletti et al., 2004). This reduction in lingual movement is in turn thought to be responsible for the speech distortions (Korpijaakko-Huuhka, Söderholm, & Lehtihalmes, 1999). In a recent study using ultrasound imaging, Rastadmehr, Bressmann, Smyth, and Irish (2008) found that the opposite was the case in a group of 10 patients with small- to medium-sized defects. Contrary to expectations, the glossectomy patients increased the height and the speed of their midsagittal tongue movement in the postoperative speaking condition. This effect was seen in all patients, regardless of the technique of defect reconstruction. It is plausible that glossectomy patients actively compensate for a loss of lingual tissue by making wider and faster movements with the residual tongue. However, such a successful active compensation for a lingual defect will only be possible up to a certain, as of yet unknown, defect size. The present study had the goal of tentatively establishing such a critical defect size based on the speech outcomes.

Methods

Participants

Twenty-two patients with tongue cancer participated in this study. There were 15 men and 7 women. The average age of the male patients was 55 years ($SD = 13.10$) and of the female patients was 45 years ($SD = 13.39$). The patients had lateral or anterolateral carcinomas with defect sizes that varied from small to large. Eleven of the patients, nine males and two females, had smaller defects that were closed using either a primary wound healing or a local closure. The remaining 11 patients, six males and five females, had larger defects that were closed using either a radial forearm flap or an anterolateral thigh flap.

Surgical mapping

The surgeons responsible for the tumour resection and reconstruction documented the location and the extent of the defect on a graphical mapping protocol that was developed by Beck et al. (1998). The defect was drawn in

the horizontal plane. The defect was traced using the NIH ImageJ software and a percentage of the amount of tissue removed was calculated. An overview of the graphical mappings of the patients' lingual defects can be found in Figure 1.

Assessment of consonant production

All speech recordings were made using the Test of Children's Speech software (TOCS+; Hodge & Gotzke, 2007; Gotzke & Hodge, 2005). The TOCS+ was originally designed for children. However, since the focus of the present investigation was not the content but the phonetic form of the patients' speech, the test was deemed appropriate. Before the recordings, it was explained to the patients that they would be working with materials for children. None of the patients voiced any concerns about the form or the content of the test materials. The patients read a list of 80 monosyllabic words in a randomized order. The monosyllabic words formed the basis for a detailed screening of the consonant inventory. All lingual consonants of English were represented in this screening procedure. The patients' speech was recorded to computer hard disk with a sampling rate of 44.1 kHz and a signal resolution of 16 bit, using an AKG C420 headset condenser microphone (AKG Acoustics, 1230 Vienna, Austria) phantom-powered by a Behringer Ultragain Pro pre-amplifier (Behringer USA, Inc., Bothell, WA 98011).

The target sounds in the monosyllabic words were assessed by the second author, who has expertise in transcription and phonetic analysis. Each sound was marked as normal or as distorted, without any further qualification of the nature of the distortion. The second author completed this task twice. Her intra-rater reliability was calculated as a percentage of agreement. The first and third authors reviewed the results from the two assessments and jointly resolved any conflicts between the first and the second perceptual assessment.

Assessment of speech acceptability

Before and after the surgery, the patients also read three 6-word sentences from the TOCS+. The technical aspects of the speech recordings were as described above. The sentences were presented in a randomized order. For the analysis of the patients' speech acceptability (i.e., the perceived "bizarreness" of their speech), five naïve listeners who did not have any training in speech-language pathology were recruited. The order of presentation of the speakers and the sentences during the listening task were randomized. The participants listened to the sound samples using Telex 1210 headphones (Telex Communications, Inc., Burnsville, MN 55337). They did not receive any perceptual training or extensive instructions for the task. The five listeners evaluated the speakers' speech acceptability on the following 4-point scale:

0 = *normal*

1 = *mildly unacceptable*

2 = *moderately unacceptable*

3 = *very unacceptable*

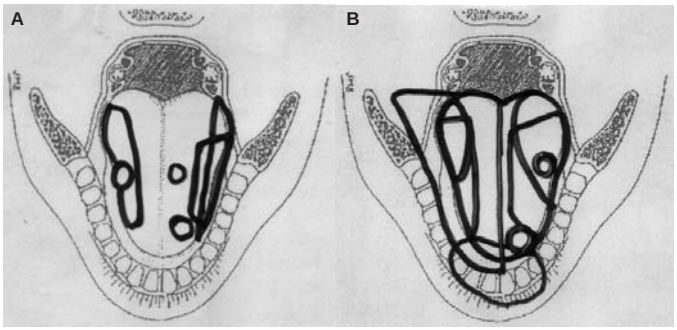

Figure 1. Graphical surgical mapping of the tumour sizes and locations as sketched by the surgeons. (A) Patients with local defect closure. (B) Patients with flap closure.

Assessment of the social perception of glossectomee speech

We also were interested to find out whether the partial tongue resection would impact the patients' social perception by listeners who were not familiar with glossectomee speech. Ten male and 13 female listeners took part in this experiment. The sentences from the speech acceptability assessment were randomized and presented together with eight rating scales. The listeners listened to each sound sample on Telex 1210 headphones and then documented their perceptual reaction using 7-point rating scales. The participants did not receive any perceptual training or specific instructions for the task. The social attributes were taken from Turcotte et al. (2009). The following positive emotional dimensions were rated: attractive, clever, sophisticated, and trustworthy. There were also four negative adjectives rated: boring, scary, annoying, and intimidating. On the 7-point scale, 1 indicated *not at all* and 7 indicated *very much*. For the quantitative analysis, the ratings on the scales for the negatively connotated adjectives were rescaled so that 1 indicated *very much* and 7 indicated *not at all*. A total score was calculated by adding the rating scores for every patient.

Results

Surgical mapping

Patients who received a local closure had on average 6.65% (*SD* = 5%; range, 2–16%) of their tongue resected. Patients who received a radial forearm flap or an anterolateral thigh flap reconstruction had on average 23.95% (*SD* = 29%; range, 5–90%) of their tongue resected. An independent-samples *t*-test was conducted to evaluate whether the percentage of tongue resected differed for patients who received a local closure and for patients who received a flap. The test approached statistical significance, $t(10.72) = 1.97$, $p = .08$ (equal variances not assumed).

Speech acceptability

The speech of all patients was scored for its acceptability pre- and post-surgery. Prior to surgery, patients who received a local closure scored on average 0.65 (*SD* = 0.34; range, 0.33–1.39) for speech acceptability, and patients who

received a flap scored on average 1.16 (*SD* = 0.62; range, 0.64–2.78). Post-surgery, patients who received a local closure scored on average 0.79 (*SD* = 0.31; range, 0.33–0.35) for speech acceptability, and patients who received a flap scored on average 1.60 (*SD* = 0.71; range, 0.78–2.72).

A two-way within-subjects analysis of variance was conducted to evaluate the effect of glossectomy surgery on speech acceptability. The dependent variable was speech acceptability. The within-subjects factors were: time with two levels (pre- and post-surgery) and surgical reconstruction with two levels (local closure and flap). There was a significant main effect for time [$F(1, 18) = 6.83$, $p = .02$], indicating that speech acceptability became significantly worse after surgery. Two independent-samples *t*-tests were conducted to evaluate whether speech acceptability differed for patients who received a local closure and patients who received a flap. Prior to surgery, patients who received a local closure were scored significantly better (i.e., lower) on speech acceptability than patients who received a flap [$t(15.65) = 2.39$, $p = .03$]. Post-surgery, patients who received a local closure were scored significantly better on speech acceptability than patients who received a flap [$t(13.67) = 3.50$, $p = .00$].

Articulation screening

Prior to surgery, patients who received a local closure distorted on average .36 (*SD* = 0.67; range, 0–2) of the target consonants, and patients who received a flap distorted on average 2.91 (*SD* = 5.0; range, 0–17) of the target consonants. Post-surgery, patients who received a local closure distorted on average .64 (*SD* = 1.03; range, 0–3) of the target consonants, and patients who received a flap distorted on average 5.09 (*SD* = 6.09; range, 0–17) of the target consonants. Since the data were non-continuous (discrete numbers), a non-parametric Mann-Whitney U test was used to compare the total number of distorted target consonants on the articulation test for patients who received a local closure and patients who received a flap. Prior to surgery, the difference between the total number of distorted consonants for patients who received a local closure and patients who received a flap approached statistical significance ($z = -1.70$, $p = .09$). Post-surgery, the difference again approached significance ($z = -1.65$, $p = .10$).

Sounds most frequently distorted

An overview of the frequencies and the distribution of the consonant errors can be found in Table 1. Prior to surgery, the total number of articulatory distortions was 36. The most frequently distorted target consonant was /g/ ($n = 5$), followed by /s/ ($n = 4$). After surgery, the total number of articulatory distortions observed was 59. The most frequently distorted target consonant was /d/ ($n = 11$), followed by /k/ ($n = 6$), /r/ ($n = 6$), /s/ ($n = 6$), and /tʃ/ ($n = 5$). Because the data were non-continuous, a non-parametric Mann-Whitney U test was conducted to compare the patients' error numbers for the articulation screening before and after surgery. The results of the test approached significance ($z = -1.70$, $p = .09$).

Table 1
Frequency of consonant distortions for all patients before and after the surgery

Phoneme	Pre-surgery number of distortions	Post-surgery number of distortions
/d/	2	11
/k/	3	6
/r/	2	6
/s/	4	6
/tʃ/	1	5
/g/	5	4
/ʃ/	3	4
/dʒ/	2	3
/n/	3	3
/ŋ/	3	3
/t/	3	2
/θ/	1	2
/z/	2	2
/l/	0	1
/v/	1	1
/b/	0	0
/f/	0	0
/h/	0	0
/m/	0	0
/p/	0	0
/w/	1	0

Social perception of glossectomy speech

Means and standard deviations of listener responses for each emotional dimension pre- and post-surgery for patients who received a local closure and patients who received a flap are reported in Table 2. A total score was calculated for each patient by summing up the ratings.

Independent-samples *t*-tests were conducted to evaluate whether the male and female listeners rated the social attributes differently. Sixteen independent-samples *t*-tests were conducted for each emotional dimension pre- and post-surgery. No Bonferroni adjustment was made in keeping with the recommendations by Perneger (1998). The results for the positive attributes demonstrated that the female listeners rated the patients as being significantly more attractive, clever, sophisticated, and trustworthy than the male listeners did ($p < .05$ for all tests). For two of the four negative emotional dimensions (rescaled), significant differences were found between the scores of male and female listeners. Female listeners rated the

speech of patients as being significantly scarier and more intimidating than male listeners did ($p < .05$ for both tests). For the other two emotional dimensions, boring and annoying, there were no significant differences between male and female listeners' ratings.

A two-way within-subjects analysis of variance was conducted to evaluate the effect of the glossectomy surgery on total score (with rescaled negative attributes). The within-subjects factors were: time with two levels (pre- and post-surgery) and surgical reconstruction with two levels (local closure and flap). The time main effect and the Surgical Reconstruction x Time interaction effect were not significant. Since we had found a difference in the rating behaviour of the female and the male listeners, the analysis was repeated for only the female and only the male listeners. The results were not significant.

A series of independent-samples *t*-tests was conducted to evaluate whether listeners perceived the speech of patients who received a local closure and the speech of patients who received a flap differently with regards to the different social attributes. Sixteen independent-samples *t*-tests were conducted for the dimensions pre- and post-surgery. The test was only significant for the attribute scary (rescaled) prior to surgery [$t(20) = 2.57$, $p = .019$]. Patients in the flap group were rated as scarier than the local closure group.

Table 2
Results for the social perception ratings of the glossectomees' speech

Attribute	Group	Before surgery	After surgery
Boring (rescaled)	Local	4.10 (*SD* .64)	4.38 (*SD* .41)
	Flap	4.44 (*SD* .58)	4.18 (*SD* .49)
Attractive	Local	2.73 (*SD* .57)	2.76 (*SD* .42)
	Flap	2.71 (*SD* .43)	2.80 (*SD* .46)
Clever	Local	3.05 (*SD* .41)	3.19 (*SD* .35)
	Flap	3.10 (*SD* .58)	3.05 (*SD* .47)
Scary (rescaled)	Local	6.38 (*SD* .19)	6.28 (*SD* .29)
	Flap	6.15 (*SD* .22)	6.32 (*SD* .25)
Annoying (rescaled)	Local	5.20 (*SD* .59)	5.46 (*SD* .32)
	Flap	5.37 (*SD* .56)	5.30 (*SD*.40)
Sophisticated	Local	3.10 (*SD*.47)	3.19 (*SD*.51)
	Flap	3.11 (*SD*.47)	3.04 (*SD*.53)
Intimidating (rescaled)	Local	6.16 (*SD*.21)	6.09 (*SD*.25)
	Flap	6.04 (*SD*.29)	6.15 (*SD*.21)
Trustworthy	Local	3.55 (*SD*.33)	3.71 (*SD*.31)
	Flap	3.55 (*SD*.38)	3.49 (*SD*.32)
Total Score	Local	34.27 (*SD* 2.72)	35.06 (*SD* 2.01)
	Flap	34.48 (*SD* 2.72)	34.33 (*SD* 2.29)

Notes: The ratings were made on a 7-point scale with the endpoints 1 (*not at all*) and 7 (*very much*). For the negatively connotated adjectives, the rating values were inverted to ensure comparability of all rating values.
SD = standard deviation

Predicting post-surgery speech acceptability from pre-surgery speech acceptability and amount of tissue resected

A linear regression analysis was conducted to predict post-surgery from pre-surgery speech acceptability. The two variables were linearly related such that the more unacceptable a patient's speech was prior to surgery, the more unacceptable that patient's speech was post-surgery. The resulting regression equation for predicting the post-surgery speech acceptability was: *Post-surgery speech acceptability* = .97 *Pre-surgery speech acceptability* + .315

The correlation between the pre- and post-surgery speech acceptability was $r = .795$ ($p = .00$), and 63.30% of the variance of post-surgery speech acceptability was accounted for by pre-surgery speech acceptability.

A second linear regression analysis was conducted to predict post-surgery speech acceptability from the defect size, as calculated from the surgical mapping protocols. The two variables were linearly related such that the larger the lingual defect, the poorer the patient's speech post-surgery. The resulting regression equation for predicting the post-surgery speech acceptability was: *Post-surgery speech acceptability* = .02 *Percentage of tongue resected* + .875

The correlation between the pre- and post-surgery speech acceptability was $r = .640$ ($p = .002$), and 41.0% of the variance of the post-surgery speech acceptability was accounted for by the defect size.

Finally, a multiple linear regression analysis was conducted to predict post-surgery speech acceptability from the combination of the pre-surgery speech acceptability and the defect size. The resulting regression equation for predicting the post-surgery speech acceptability was: *Post-surgery speech acceptability* = .011 *Percentage of tongue resected* + .8 *Pre-surgery speech acceptability* + .309

The correlation between the two variables and the post-surgery speech acceptability was $r = .861$ ($p < .001$), and 74.2% of the variance of the post-surgery speech acceptability was accounted for by the regression equation.

In order to identify a tentative cut-off point for the surgical defect size after which postoperative speech acceptability deteriorated markedly, a Receiver Operating Characteristic (ROC) curve was plotted. The state variable was defined as a speech acceptability rating of 1.5 or higher (i.e., more than *mild*). The ROC identified a cut-off of 20.4% tongue surface removed (sensitivity 75% and specificity 94%).

Discussion

This study evaluated the speech characteristics of a small, convenience-sampled group of partial glossectomy patients. The graphical surgical mapping demonstrated that the patients with the local closure had smaller defects than the patients with the flap reconstructions. This finding was expected because the surgeons use flaps for the larger defects. The method of defect reconstruction was used as a sorting variable between the patients with smaller defect sizes and the patients with more extensive defect sizes.

Speech acceptability is a relatively crude outcome measure. Nevertheless, it differentiated well between patients with different degrees of articulation disorders, and it had the advantage that untrained naïve listeners could be recruited to complete the assessments. Both groups' speech acceptability worsened significantly after the surgery, which was an expected finding. It also was found that the patients with larger defects and flap reconstructions had poorer speech acceptability than the patients with smaller defects and local reconstructions. This difference was noted before and after the surgery. The observation that even before the surgery patients may have reduced speech acceptability is of importance for rehabilitation as well as for research. We should not assume that the pre-surgical speech of the patient will always be error-free. However, it is unclear what may cause the reduced speech acceptability. Some patients may have pre-existing speech errors and, in other patients, the presence of the tumour may impact on the normal tongue movement.

While the speech acceptability assessment showed clear effects of the tumour and the surgery, the results of the articulation screening were less pronounced. It was found that the patients with the larger defects and flap reconstructions had poorer results before as well as after the surgery. However, relatively few consonants were noted to be distorted, even in patients with markedly reduced speech acceptability. The articulation screening that was used in the present study was not formally set up for this purpose. The fact that the target sounds were mostly in single syllable words may have allowed the patients to enunciate with more clarity than they may have shown in connected speech. Vowels were not assessed in this screening, so it was not possible to determine whether vowel distortions would have influenced the listeners' acceptability assessments more than the consonant distortions.

Since there were relatively few consonant distortions observed, the hierarchy of consonant distortions may be of limited transferability to other groups of glossectomy patients. As reported by Bloomer and Hawk (1973), Kalfuss (1968) evaluated the speech of 22 glossectomy patients and noted distortions of the vowel /i/ and of the consonants /l/, /v/, /k/, /g/, /ϴ/, /ð/, /s/, /z/, /ʃ/, /tʃ/, and /dʒ/. Beck et al. (1998) noted distortions of /r/, /l/, /s/, /z/, /ʃ/, /tʃ/, and /dʒ/ in five patients with floor of mouth resections and /r/, /j/, /l/, /s/, /k/, and /ʃ/ in five patients with resections of the dorsum of the tongue. The rank order found in our study differs slightly from these previous studies. The differences are probably explained by differences in the defect sizes and locations as well as the reconstructive techniques employed by the surgeons.

Reduced speech acceptability may be associated with social stigmatization, which could be detrimental to the patient's emotional well-being and quality of life (Radford et al., 2004). However, the results of the ratings of the social attributes did not demonstrate systematic changes in the social attributes that were ascribed to the patients' voice and speech. While there was a single significant *t*-test indicating that patients in the flap group were rated as scarier than the local closure group, this finding should not be overstated in the face of the non-significant analyses of variance. Overall, the findings indicated that the post-surgical deterioration in speech acceptability and articulation was not inevitably associated with negative social perceptions. In future research, it would be interesting to juxtapose the assessment of social perceptions of naïve listeners with the patients' self-assessments.

It was also an interesting observation that the female listeners in the group tended to be more positive in their ratings of positive attributes and more negative in their ratings of negative attributes than were the male listeners. This finding was observed in six out of the eight perceptual dimensions. Previous research by Turcotte et al. (2009) and Rieger et al. (2006) had not found any gender effects for their listeners.

Since speech acceptability appeared to be the outcome measure that differentiated most clearly between the different speakers, regression analyses were calculated to predict post-surgical speech acceptability from preoperative acceptability and from the defect size. The results showed that the pre-surgical speech acceptability accounted for 63.3% of the variance of the post-surgical speech acceptability, while the amount of tissue predicted 41% of the variance. When both measures were combined, the cumulative predictive value increased to 74.2%. If these findings could be replicated with a larger and more diverse group of patients, they might have direct consequences for the pre-surgical assessment and counselling process.

The ROC method identified a defect size of more than 20.4% tongue tissue as the critical cut-off for poorer speech acceptability. The resulting sensitivity of 75% and the specificity of 94% were satisfactory. A cut-off of 20% tissue loss appears plausible from a clinical perspective. Obviously, these results need to be treated with caution. The cut-off only considers the defect size and neglects the defect location. The sample size in the present study was small and may not have adequately represented the whole variety of possible tongue defects.

Glossectomy surgery and its speech outcomes are notoriously difficult and still not completely predictable in their outcomes. The present study demonstrated a disconnect between the number of consonant distortions and the resulting assessment of speech acceptability. Speech acceptability appeared to be the more sensitive measure of the "differentness" of the patients' speech. On

the other hand, the research also demonstrated that while listeners rated the patients' speech as less acceptable after the surgery, the rated social perceptions of the speakers did not change.

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