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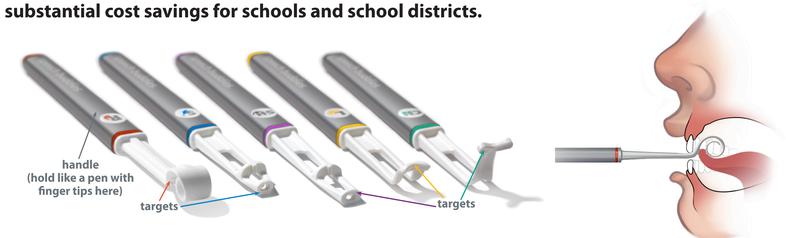
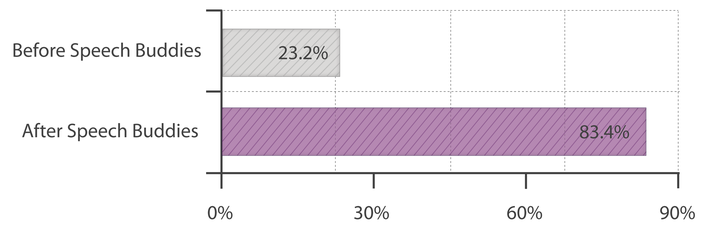
# Examining the Effectiveness of Tactile Biofeedback in Charter Schools

## ABSTRACT

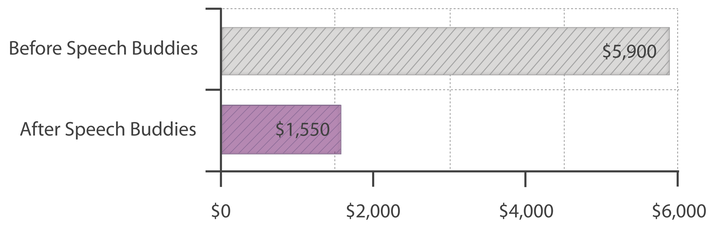
**This study examined the effectiveness of the integration of tactile biofeedback, using the Speech Buddies® tool set, into a typical school-based service delivery model at five New York City charter schools. Students aged 4:10 to 16:00 presented with either articulation goals on their individual education plans (IEP), or a baseline phoneme accuracy of 15% or lower on Secord Contextual Articulation Test (S-CAT) phoneme probes. 77% of students received group-based therapy, 69% had IEP language goals, and 42% were older students with treatment-resistant residual errors. Over the course of the school year, the students were administered an average of 25.2 hours of total speech and language therapy (17.9 hours of articulation therapy) and the student's average accuracy on the S-CAT test increased from 23.2% to 83.4%. The average cost of therapy delivered per student prior to the study was $5,900 while the average cost of therapy delivered per student using Speech Buddies was $1,550. These results show a substantial comparative improvement over traditional articulation therapy, an effective administration of group therapy, and a substantial cost savings for schools and school districts.**



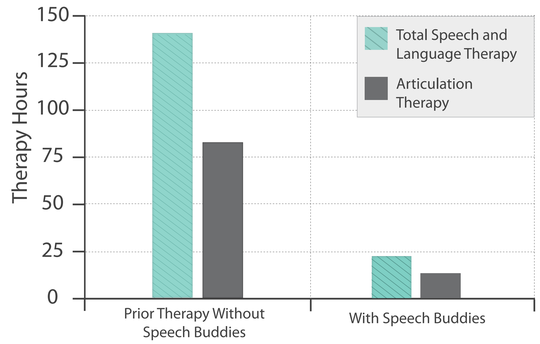

## Initial and Final Mean Accuracy from S-CAT Assessment




## Average Therapy Cost Per Student




## Therapy Hours are Nearly 1/5




**Predicted Performance with Speech Buddies use on S-CAT accuracy percentage: least squares**

| Timepoint (mean therapy) | Predicted performance accuracy on S-CAT | Lower Bound (α=.05) | Upper Bound (α=.05) | T | Pr>\|t\| | Standard Error |
|---|---|---|---|---|---|---|
| Assessment 1 ( 5.7 hours) | 43.12% | 31.28 % | 54.96% | 7.60 | <.0001 | 5.68% |
| Assessment 2 (11.4 hours) | 63.33% | 50.91% | 75.74% | 10.64 | <.0001 | 6.00% |
| Final Assessment (17.4 hours) | 80.67% | 68.82% | 92.51% | 14.21 | <.0001 | 5.68% |

## Subjects

To be included in the study, the students were required to have either: 1) articulation goals as part of an Individualized Education Plan (IEP); or 2) baseline accuracy of 15% or less on at least one phoneme-specific probe for the /r/, /l/, /s/, /ʃ/, or /tʃ/, according to the Secord Contextual Articulation Test (S-CAT). Twelve students were included in the study. 75% of subjects met this inclusion criterion via articulation-based IEP goals; 25% of subjects met this criterion by scoring 15% or less on the S-CAT probes. Of these 12 students, 69% had IEP language goals, and 92% had received therapy in the prior school year or summer. Ages ranged from 4:10 to 16:00, with the average age being 8:7. One subject had moderate bi-lateral hearing impairment with hearing-related IEP goals and one subject had enlarged adenoids which contributed to a significantly hyponasal voice.

## Methods

The Speech Buddies® device set for /r/, /l/, /s/, /ʃ/ or /tʃ/ was used in this study. The figures above depict the devices, show the different target locations, and show the /r/ device within the oral cavity. The /r/ device targets the retroflexed (apical) configuration of /r/. The ridges on the device coil cue the correct starting position. The subject is then instructed to unfurl the coil during real-time production of /r/ in isolation or in words to achieve correct tongue retroflexion. The /s/ and /ʃ/ devices place the tongue tip target 8mm and 12mm behind the upper front dentition respectively, the /tʃ/ target is centered flush against the alveolar ridge and prompts tongue blade contact, and the /l/ places the tongue tip target behind the upper front dention. All devices can be used to teach productions in isolation or in words.

This IRB-approved study was performed at five New York City charter schools by five licensed and certified speech-language pathologists (SLPs). Speech Buddies were included as the primary cuing mechanism throughout the school year as deemed necessary by the SLP. Mean therapy hours administered for all subjects was 25.2 hours at an average rate of one hour per week. 77% of subjects received group therapy. The average number of error phonemes treated was 2.3 phonemes.

## Methods (cont.)

All assessment data were gathered by the assigned SLP. S-CAT probes were administered at baseline, at two mid-points during the school year, and during a final assessment. The S-CAT measures accuracy of production for particular phonemes at the word and sentence levels.

## Results

As shown in the figures above, average accuracy at producing the error phonemes, as measured by the S-CAT probes, increased from 23.2% to 83.4%. Additionally the estimated cost of therapy averaged $1,550 per student. The estimated average cost of previous therapy, despite generally minimal progress, for the same cohort was approximately $5,900 per student. This cost estimates were derived from documentation of previous therapy, assumed an average of three students per group therapy session, and an average SLP school-based compensation listed in the 2010 ASHA Schools Survey.[1]

The figure in the top right highlights duration of therapy administration. Mean hours administered was 25.2 with a mean of 17.9 hours focused specifically on articulation therapy. Average prior speech therapy for the group was 139.9 hours with 83.7 hours on articulation therapy.

A repeated-measures mixed model was used to test the effect of Speech Buddy use on performance over time using SAS Version 9.2 (SAS Institute Inc., Cary, NC.) Initially, baseline performance, age, presence of language disorder, hours of therapy, hours of previous therapy, receipt of individual therapy, and number of problematic phonemes were the covariates. As baseline performance was the only significant covariate, a final parsimonious model was run including only baseline performance as a covariate. Baseline performance remained a significant covariate ($F(1,68)=15.87$, $p=.0002$) and participants improved over time ($F(2,20)=18.30$, $p<.0001$). Post-hoc comparisons of the predicted performance means showed participants performed significantly better at interim assessment 2 and the final assessment than at interim assessment 1, ($t=2.94$, $p=.008$, $t=6.05$, $p<.0001$, respectively) and better at the final assessment than interim assessment 2 ($t=2.83$, $p=.01$). The table above shows predicted performance accuracy with 95% confidence on the S-CAT probe, examining the time effect shown by average hours of articulation therapy. There were 20 degrees of freedom for each timepoint.

## Results (cont.)

## Discussion

The results above suggest that the integration of Speech Buddies into school based therapy programs yielded a significant treatment response. This response was achieved in nearly 1/5 the number of therapy hours and at nearly 1/4 the cost, as compared to previous therapy delivered to study subjects. Therapy gains were consistent for subjects that were either new to treatment or presented with treatment-resistant, residual articulation errors. 42% of subjects were age 11 and older and had been in speech therapy for several years.

The data also compare favorably to industry norms, as reported by Jacoby, Lee, Kummer, Levin & Creaghead (2002), where a similar population treated individually in a hospital-based clinic setting achieved comparable gains. Gains reported by Jacoby et al. were achieved in an average of 40.3 hours at an estimated cost of $3,224 per student while gains with Speech Buddies in a group setting were achieved in an average of 25.2 hours, with an estimated cost of $1,55-0 per student.[2]

The study design was intended to reflect current school-based clinical practice. Results were obtained according to the current IEP-mandated service delivery paradigm of the vast majority of school districts in the United States: one hour per week of therapy per student, group therapy. The significant improvement in accuracy of production for students using tactile biofeedback within this paradigm would represent a substantial potential cost savings for school districts. Furthermore, this trend could have the potential to reduce caseload sizes and increase SLP retention rates in an environment of reduced public sector spending.

References:
1) American Speech-Language and Hearing Association, 2010 Schools Survey, (2010) p. 1-7
2) Jacoby, G., Lee, L, Kummer, A, Kevin, K., and Creaghead, N. (2002). The number of individual treatment units necessary to facilitate functional communication improvements in the speech and language of young children. *American Journal of Speech-Language Pathology* 11, 370-380, (n=111 for 4, 5, and 6 year olds, gains comparable to increase of two or more functional communication units for articulation, hospital rate estimated at $80/hour)