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## Does behavioral treatment for children with social anxiety disorder change vocal characteristics?

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DOES BEHAVIORAL TREATMENT FOR CHILDREN WITH SOCIAL  
ANXIETY DISORDER CHANGE VOCAL CHARACTERISTICS?

by

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for the Honors in the Major Program in Psychology  
in the College of Sciences  
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## **Abstract**

Children with Social Anxiety Disorder (SAD) characterized by persistent shyness and anxiety in social or performance situation, exhibit social skills deficits. These deficits include difficulty initiating conversations, maintaining eye contact, and taking turns when speaking, which in turn leads to impairments in their daily interactions and development of peer relationships (Greco, 2005; Miers, 2010). Although there are many subjective assessments for treatment outcomes for children with SAD, in order to become more thorough and effective when assessing treatment outcomes, more objective measures of actual behaviors are needed. This study uses digital vocal analysis to examine vocal parameters associated with anxiety such as pitch and volume in children with SAD pre and post treatment. Measuring vocal parameters during role-play behavioral assessment tasks allowed us to examine whether the software was capable of detecting differences in vocal characteristics that are consistent with the clinical presentation of the disorder. Children with SAD showed differences in vocal characteristics pre to post treatment, in regards to pitch, pitch variability, volume, and volume variability. There were significant changes in volume pre to post treatment, however the changes in pitch, pitch variability, and volume variability were not significant. These results suggest that post SET-C treatment, certain vocal characteristics, (one of the social skills deficits exhibited by children with SAD) improved. Implications of the findings are discussed.

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## **Introduction**

Social anxiety disorder (SAD) is characterized by persistent shyness and anxiety in social or performance situations, particularly upon exposure to unfamiliar people or when embarrassment may occur (American Psychiatric Association [APA], 2000). Feared situations may include public speaking, eating in front of others, and meeting or speaking to new people. Approximately 1-9% of children in the general population and approximately 32% of children seeking and/or undergoing treatment meet criteria for SAD (Kendall et al., 1997). The onset of SAD is most often in mid to late adolescence, with children as young as eight years old being diagnosed with this disorder (Beidel, 2000). Regarding sex differences, SAD is more commonly diagnosed among females (Essau et al., 1999; Wittchen et al., 1999).

In addition to experiencing anxious arousal, children with SAD exhibit social skills deficits, including difficulty initiating conversations, maintaining eye contact, and taking turns when speaking, leading to impairments in their daily interactions and development of peer relationships (Greco, 2005; Miers, 2010). Individuals with SAD are more likely to show social skills deficits in unstructured social interactions (e.g., mingling at parties, impromptu conversations) compared to structured tasks (Spence, Donovan, & Brechman-Toussaint, 1999). Other characteristics of children with SAD include avoidance and refusal to speak. Adolescents experience a more persistent pattern of avoidance and distress than children that increases with age (Beidel et al., 2007).

Positive treatment outcome for childhood SAD have come from medications such as selective serotonin reuptake inhibitors (SSRIs; Birmaher et al., 1994), cognitive behavior therapy

(Kendall, 1994; Kendall et al., 1997), and treatments combining exposure therapy with social skills training (e.g., Social Effectiveness Therapy for Children [SET-C]; Beidel, Turner, & Morris, 2004). Among the psychological treatments, Cognitive Behavioral Group Therapy for Adolescents (CBGT-A) was the first intervention specifically for childhood SAD (Albano et al., 1995). CBGT-A involves cognitive restructuring, social skills training, and exposure. Exposure involves arranging for the child to come into contact with the situations they fear (i.e. speaking in front of others, eating in public) until their anxiety dissipates (Beidel, Turner, Young, & Paulson, 2005). SET-C is an empirically supported behavioral treatment created to decrease social anxiety through individual in vivo exposure sessions and group social skills training (SST). Through SST, children are able to acquire social skills necessary to effectively interact during social situations. Improvements in children treated with SET-C included a decrease in social fear and an increase in social skills made evident by parent-child ratings and behavioral observations (Beidel, 2004).

The assessment of treatment outcome for childhood social phobia includes diagnostic interviews, self-report measures, clinician ratings and behavioral assessment of actual skill and anxiety when the child is engaged in social encounters. Behavioral assessment uses direct observation of children's social interactions. Observer ratings and coding schemes are used to evaluate behavioral assessments such as role play tasks or read-aloud tasks, both of which have been used to assess treatment outcome (Beidel et al., 2000; Beidel et al., 2007). The advantage of behavioral assessments is that the child's behavior is observed directly without the filter of self or parental report, and provides an unbiased assessment of treatment outcome, representing a

valuable addition to the assessment armamentarium. They are limited however, in that the ratings are often global in nature and are based on constructs such as “efficacy in the situation” or “observed anxiety.” Even with rigorous training and ongoing inter-rater reliability, the ratings remain somewhat global in nature, and do not specifically address how the child has improved or what specific behaviors have changed to make the child appear more effective in social interactions. Thus, although objective assessment of social behaviors by raters blinded to treatment condition play an integral role in obtaining an overall assessment of treatment outcome, these ratings have their limitations. In order to become more thorough and effective when assessing treatment outcomes, more objective measures of actual behaviors are needed.

In addition to global ratings of social behavior such as effectiveness or anxiety, observers are sometimes asked to rate molecular behaviors such as eye contact or voice tone. To date, these ratings are still defined primarily in subjective terms such as “appropriate” or “not appropriate.” Sophisticated (and expensive) eye trackers now can be used to determine the object of a speaker’s eye gaze. Most recently, digital vocal analysis is providing social skills researchers the ability to objectively analyze vocal tone, which in turn, can reveal a great deal about an individual’s emotion when speaking.

Thus far, vocal quality has been evaluated in adolescents and adults with autism. In one study with males with autism ranging from 10-49 years of age, voice monotony was noted along with deficits in vocal pitch and volume (Shriberg, Paul, McSweeny, Klin, & Cohen, 2001). Additionally, the deficits in vocal quality were likely to be consistent and lack change over time. Vocal characteristics have also been evaluated when looking at changes in emotional responses



for certain emotions. Although one study (Laukka et al., 2008), showed a positive relationship between decreased anxiety and changes in nonverbal vocal behavior, the parameters and assessments used were subjective (observer ratings.)

Little to no research has analyzed speech characteristics during behavioral assessments using objective methods of assessment. As noted, digital analysis of vocal characteristics quantifies features of verbal speech that are not easily detected. Vocal parameters known to carry emotional aspects of the voice include pitch and pitch variability whereas those used to measure social responsiveness include vocal volume and volume variability. To date, only one study of which we are aware, has used digital vocal analysis to examine speech quality among typically developing children, social phobic (SP) children and children with Asperger's disorder (AD) (Scharfstein et al., 2011). The data indicated that children with SAD had a lower vocal volume average in comparison to typically developing (TD) children as well as lower volume variability. In terms of pitch, children with SAD had higher pitch and increased pitch variability. Children with Asperger's disorder had lower vocal volume, pitch, and pitch variability. This finding was consistent with the clinical symptoms of monotonic speech in children with AD and "fearful" characteristics of children with SAD (Scharfstein et al., 2011). Given its significant promise as a tool for the assessment of emotion, assessing its ability to detect emotional changes as a result of treatment would be useful. The purpose of this study was to determine if documented improvement in children with social phobia, heretofore documented with self-report and global ratings of effectiveness and anxiety are reflected in vocal characteristics, using digital vocal analysis.

In this study, it was hypothesized that:

- 1.) In comparison to pre-treatment, children with SAD will show lower pitch and higher vocal volume after treatment.
- 2.) After treatment, the vocal characteristics in children with SAD will be closer to the characteristics of typically developing children.
- 3.) There will be a significantly positive relationship between blinded observer's ratings of skill and anxiety for children with SAD at post-treatment and their vocal characteristics as measured during behavioral assessment of social skill.

## **Method**

### Participants

Data from a total of 30 children, ages 7-15, treated with SET-C (Beidel et al., 2007) comprised the sample for the current study. The data came from a larger study examining the efficacy of SET-C in comparison to fluoxetine and pill placebo. Participants were recruited by electronic or print media or by clinical referral to the specialty treatment clinic. The inclusion criterion for this study was a primary diagnosis of SAD with no previous trials of a selective serotonin reuptake inhibitor (SSRI) or behavioral therapy. This current study sample included children who completed SET-C treatment from Beidel et al. (2007) with pretreatment and post treatment behavioral assessments completed (n = 30).

### Diagnostic Interview

At pretreatment, based on the Anxiety Disorders Interview Schedule for Children and Parents (ADIS-C/P; Silverman & Albano, 1996) all children met criteria for a primary diagnosis of childhood SAD. The ADIS is a child and parent semi-structured diagnostic interview that is a reliable and valid assessment tool for diagnosing childhood SAD. Clinical psychologists, psychiatrists, or graduate students in clinical psychology doctoral programs administered the interviews. The clinician interviewed the parent and then the child, receiving the information from which the diagnoses were based.

## Treatment

The data from thirty children who were treated with SET-C from the Beidel et al. (2007) were included in this study. SET-C (Beidel, D.C., Turner, S.M., & Morris, T.L., 2004) is a multicomponent behavioral treatment program designed to reduce social anxiety and enhance social skills through group social skills training and peer interaction tasks, and individual in vivo exposure. SET-C is twelve weeks in length including one group social skills training session, one peer generalization session, and one individual in vivo exposure session per week. *Social skills training* (SST) focused on developing the child's general social skills, including greetings, initiating and maintaining conversations, and use of assertive skills. Training sessions were conducted in groups of approximately five children and directly following social skills training sessions, children participated in *peer generalization sessions*, wherein children practiced their newly acquired social skills by interacting with typically developing children in everyday social settings (e.g., bowling, arcades, museums, and basketball courts.) Additionally, *in vivo exposure* allowed the child to confront their specific social fears in order to overcome them.

## Behavioral Assessment Task (BAT)

To measure and assess social skills, every child participated in a structured role play assessment (Beidel, Turner, & Morris, 1999) which included five brief scenarios with a same-age peer with no history of psychological disorder. These scenarios required interactions with same-aged peers (i.e., starting a conversation with an unfamiliar child, offering help, giving a compliment, receiving a compliment, and responding assertively to improper behavior). This task lasted for about three to five minutes in total. Every child was instructed to picture the scene

and to respond as if it were really taking place. The experimenter described the scene (e.g., “in gym class, you are learning how to play basketball and how to shoot free throws. You are having trouble making some shots from the free throw line. Another boy who is a good basketball player says...”) and a same-age peer, began the interaction by reading a scripted line provided on an index card (e.g., “Would you like for me to help you with your free throws?”). The child responded accordingly. The peer then read a second scripted line (e.g., “Well, it was hard for me to learn at first. Would you like for me to give you some pointers”) to which the child responded accordingly. This progression was repeated until all five scenes were completed. To allow for any questions and clarifications, a practice scene was presented first. Typically developing peers were advised to maintain eye contact and allow approximately ten seconds for the child to reply before speaking again.

### Vocal Characteristics

The principal qualities of vocal characteristics are pitch and volume. Pitch can be defined as the mean frequency of a voice sample (Kimble & Seidel, 1973). Signs of anxiety and emotional aspects can be derived from the pitch. Increased vocal pitch is synonymous with higher levels of anxiety as a physiological result of vocal chords stiffening in the neck. Additionally, heightened anxiety is linked to vocal pitch variability, which is subjectively heard as pitch edginess and jitteriness (Fuller et al. 1992). Intensity is a second vocal characteristic, defined as mean peak amplitude of the voice, subjectively heard as voice volume (Kimble & Seidel, 1973). Inconsistency in voice volume is known as vocal volume variability or the standard deviation of vocal volume. The PRAAT vocal analysis software program (Boersma &

Weenink, 2005) was used to evaluate these vocal characteristics for responses of participants during the behavioral assessment tasks. The PRAAT software is a computerized linguistic analytic program commonly used by linguists and others to analyze vocal qualities such as voice volume and vocal pitch. The process involves stripping the vocal files from the digitized recording of the social interaction. Then, the digital files are edited to isolate only the responses of the participants. Each response is then run through the linguistic software, resulting in a mean score for each of the four vocal characteristics assessed in this study. These four vocal characteristics include voice volume, voice volume variability, vocal pitch, vocal pitch variability.

## Results

### Pre-treatment comparisons

Prior to behavioral treatment, the vocal characteristics of children with SAD were compared to typically developing children. Using a series of ANOVAs, children with SAD had higher pitch ( $M= 320.46$  vs.  $M=293.19$ ,  $F= 5.26$ ,  $p=.026$ ), lower voice volume ( $M= 49.62$  vs.  $M= 59.03$ ,  $F= 41.78$ ,  $p=.000$ ), and lower voice volume variability ( $M= 3.23$  vs.  $M= 5.15$ ,  $F=14.33$ ,  $p=.000$ ) compared to children with no disorder. Groups did not significantly differ on the variability of pitch ( $M= 72.59$  vs.  $M= 62.12$ ,  $F=2.54$ ,  $p=.116$ ). See Table 1.

### Post-treatment comparisons

*Within group changes.* Using a series of paired samples t-tests, digital analyses of vocal characteristics revealed that voice volume in children with SAD showed statistically significant increases from pre ( $M= 44.66$ ) to post treatment ( $M=51.24$ ,  $p=.019$ ). There was no significant change in pitch ( $M= 277.73$  vs.  $M= 300.62$ ,  $p=.261$ ), pitch variability ( $M= 62.91$  vs.  $M= 72.92$ ,  $p=.132$ ), or in volume variability ( $M= 2.90$  vs.  $M= 3.52$ ,  $p=.069$ ) as shown by Table 2.

*Between group differences.* Another way to assess improvement in vocal characteristics as a result of treatment is to compare the scores of the children with SAD to children with no disorder. Whereas the with group change measures improvement, the between group comparison assesses whether this change is substantial enough that the children with SAD can no longer be differentiated from children with no disorder. To examine this, ANOVAs were conducted on all 4 variables. The results indicated that after treatment, vocal pitch in children

with SAD ( $M= 313.06$ ) was not significantly different than mean pitch in children with no disorder ( $M= 293.19$ ,  $F= 3.00$ ,  $p=.089$ ). The groups were still significantly different on pitch variability (children with SAD,  $M= 74.59$  vs. children with no disorder,  $M=62.12$ ,  $F=4.05$ ,  $p=.049$ ). After treatment, volume in those with SAD was not significantly different from controls ( $M= 52.78$  vs.  $M=59.03$   $F= 15.05$ ,  $p=.000$ ) but there was still a group difference on volume variability (children with SAD,  $M= 3.60$  vs. children with no disorder,  $M=5.15$ ,  $F=12.39$ ,  $p=.001$ ). See Table 3.

#### Correlations between skill and anxiety

Correlational analyses were conducted to determine the relationship between blinded observers ratings of skill and anxiety for children with SAD during the post treatment post treatment behavioral assessment and their vocal characteristics. There was a significant correlation between observer's ratings of skill for children with SAD and voice volume. However, there was no significant correlation between observer ratings of anxiety and vocal characteristics post treatment. As observer ratings increased, variability in pitch and volume decreased but not significantly. Similarly, observer ratings of skill were not significantly correlated with mean pitch, mean pitch variability, or mean volume variability.



## Discussion

The purpose of this study was to determine if documented improvement in children with SAD, heretofore documented with self-report and global ratings of effectiveness and anxiety are reflected in vocal characteristics, using digital vocal analysis. A second objective was to determine whether the vocal characteristics in children with SAD approach characteristics of children with no disorder. Research has indicated that the examination of speech quality through digital vocal analysis has only occurred once, to date, among typically developing children, children with SAD, and children with Asperger's disorder (AD) (Scharfstein et al., 2011). To our knowledge, this is the first study to use digital vocal analysis as a tool to document change or improvement in treatment outcomes between children with SAD and normal controls.

Digital vocal analysis, consistent with previous research, identified a distinct pattern of vocal characteristics in children with SAD and typically developing children (Scharfstein et al., 2011). Children with SAD spoke more softly (i.e., lower volume) and had less variability in their voice volume as well as higher pitch and more pitch variability than typically developing children. Overall, the results of this investigation indicate that as a result of treatment, children with SAD displayed some vocal characteristic changes that were evident during short, structured scenarios created to represent everyday situations (i.e., receiving help, giving compliments, responding to a bully). With respect to voice volume, children with SAD showed a significant increase from pre to post treatment, whereas changes in volume variability occurred but was not significant. Similarly, there were no significant changes in pitch and pitch variability.

Prior to behavioral treatment, children with SAD exhibited lower pitch, lower voice volume, and consistently lower voice volume variability compared to typically developing children. Groups did not significantly differ on the variability of pitch. Results revealed that after treatment, mean pitch in children with SAD was not significantly different than means for the TD children, suggesting positive treatment outcomes in children with SAD treated with SET-C. However, volume, pitch variability and volume variability of children with SAD were still significantly different from typically developing children. Thus, while one of four variables appeared to change as a result of treatment, others did not.

Previous research suggests that the social skills deficits exhibited by children with SAD should improve with social skills training programs provided by SET-C treatment (Beidel et al. 1999, 2007; Spence et al. 1999). Our findings are consistent with these research suggestions because post SET-C treatment certain vocal characteristics, (one of the social skills deficits exhibited by children with SAD) improved. These results suggest that children with SAD changed in the emotional aspects of their voice including pitch and pitch variability. Improving in the emotional aspects of voice involves having lower vocal pitch, which is associated with lower levels of anxiety, and a decrease in pitch variability, which is heard as less jitteriness in the voice. Furthermore, children with SAD demonstrated significantly increased voice volume post treatment indicating improvement from low vocal volume, a characteristic of social skills deficits. However, post treatment pitch in children with SAD was not significantly different from typically developing children suggesting that treatment was successful in reducing anxiety as shown by pitch.

This investigation has several limitations. First, this study evaluated vocal characteristics in children with SAD during structured social interactions. Social behaviors of children were measured through scripted role-play scenarios. During each scenario, notwithstanding the target child's response to the first prompt, the peer read a second scripted line, at times leading to unusual and interrupted responses. The structure may have reduced the target child's ability to respond naturally and to the extent they would in an unstructured role-play. Additionally, the interactions were very brief. Allowing the children to speak longer may have provided for a more natural interaction, allowing for a larger speech sequence to be analyzed. Further, background noise (i.e., doors closing, people speaking in adjacent rooms) disallows an accurate analysis through the PRAAT software, adding extraneous noises to the child's vocal analysis.

To summarize, using digital vocal analysis to examine vocal characteristics in children with SAD during brief, social interactions with peers from pre to post treatment suggested many changes. Children with SAD showed significant improvements in their voice volume yet no significant changes in volume variability or emotional aspects of their voice including pitch and pitch variability. Yet when comparing children with SAD to typically developing children post treatment, their pitch demonstrated enough change such that these characteristics were no longer significantly different from children with no disorders, suggesting positive treatment outcomes. However, children with SAD still differed significantly in their volume, pitch variability, and volume variability from typically developing children. Therefore, despite vocal characteristics such as pitch, pitch variability, volume, and volume variability improving post treatment, more research is necessary to qualify what can specifically be done in treatment to focus on isolating

vocal characteristics to further alleviate anxiety in children with SAD. Vocal analysis is a critical objective measurement in assessing treatment outcomes in a more thorough, effective way in children with SAD.

## **Appendix A: Table 1**

**Table 1: Mean scores for vocal characteristics for Social Anxiety Disorder (SAD) and Normal Controls (NC) at pre-treatment**

Vocal Characteristics	Pre-treatment n=26 M (SD)	Typically Developing n=29 M (SD)	p value
Mean pitch	320.46 (57.3)	293.19 (27.1)	.026*
Mean pitch variability	72.59 (24.2)	62.12 (24.4)	.116
Mean volume	49.62 (4.6)	59.03 (5.9)	.000*
Mean volume variability	3.23 (1.7)	5.15 (2.0)	.000*

## **Appendix B: Table 2**

**Table 2: Social Anxiety Disorder (SAD) Pre to Post Vocal Characteristics**

Vocal Characteristics	Pre-treatment n=30 M (SD)	Post-treatment n=30 M (SD)	p value
Mean pitch	277.73 (122.9)	300.62 (76.9)	.261
Mean pitch variability	62.91 (33.7)	72.91 (24.5)	.132
Mean volume	44.66 (15.75)	51.24 (11.3)	.019*
Mean volume variability	2.90 (1.9)	3.52 (1.3)	.069



## **Appendix C: Table 3**

**Table 3: Social Anxiety Disorder (SAD) Post means to Normal Controls (NC) means**

Vocal Characteristics	Post-treatment n=26 M (SD)	Typically Developing n=29 M (SD)	p value
Mean pitch	313.06 (54.7)	293.19 (27.1)	.089
Mean pitch variability	74.59 (21.2)	62.12 (24.4)	.049*
Mean volume	52.78 (6.0)	59.03 (5.9)	.000*
Mean volume variability	3.6 (1.2)	5.15 (2.0)	.004*

## Appendix D: Table 4

**Table 4: Post Observer Ratings of Anxiety and Skill**

		Anxiety	Skill
Observer Ratings	Pearson Correlation	1	1
	N	30	30
Mean Pitch	N	29	29
	Sig. (2-tailed)	.703	.615
	Pearson Correlation	.074	-.097
Mean Pitch Variability	N	29	29
	Sig. (2-tailed)	.233	.670
	Pearson Correlation	.229	-.083
Mean Volume	N	29	29
	Sig. (2-tailed)	.542	.985
	Pearson Correlation	.118	.004*
Mean Volume Variability	N	29	29
	Sig. (2-tailed)	.479	.700
	Pearson Correlation	-.137	.075

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