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A Two-Session Hierarchy for Shaping Successive Approximations of Speech in Selective Mutism: Pilot Study of Mobile Apps and Mechanisms of Behavior Change

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Selective mutism (SM) is an anxiety disorder marked by withdrawal of speech in particular social situations. Treatment is often difficult, requiring attention to several characteristics particular to the disorder. Therapeutic tools and activities such as games and mobile applications (apps) may be particularly advantageous to behavioral therapy for SM. A 2-session hierarchy for shaping successive approximations of speech in SM was piloted with 15 children, 5 to 17 years old, who were randomly assigned to shaping while using mobile apps, other therapeutic tools/activities, and reinforcement alone. Very strong treatment gains were observed: 13 of 15 (88.7%) children completed the hierarchy during the first session and 14 (93.3%) did so during the second session, with the final child completing all but the final step (i.e., to ask and respond to at least 5 open-ended questions). Moreover, all 15 children spoke to the clinician within 59 minutes of treatment (M = 17 minutes), and 14 (93.3%) children held five, 5-minute conversations with additional unknown adults during the second session. This occurred regardless of the inclusion of therapeutic tools/activities, although preliminary patterns of responding were observed such that children shaped while using mobile apps tended to show less self-reported and physiologically measured anxious distress. The utility of therapeutic activities and mobile apps when treating SM is discussed as well as areas for future research.

Keywords: selective mutism; treatment; mobile app; technology; *m*Health

Selective mutism (SM) is an anxiety disorder marked by a consistent failure to speak in certain social situations during which speech is expected (e.g., at school), despite speaking in others (e.g., at home). This often results in significant impairment in academic and/or social achievement (American Psychiatric Association [APA], 2013). SM typically develops at a young age (i.e., 2.7 to 4.1 years) and its associated early impairment may inhibit social and scholastic development as children age (Cohan, Price, & Stein, 2006; Garcia, Freeman, Francis, Miller, & Leonard, 2004; Viana, Beidel, & Rabian, 2009). As such, early identification and effective, efficient intervention for children who develop SM is critical.

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The treatment of SM is often difficult and there are several factors that inform the behavioral conceptualization of SM and contribute to the development and maintenance of the disorder that should be targeted as a part of treatment. These include positive and negative reinforcement for not speaking in certain settings (see Mowrer's two-factor theory; Mowrer, 1947), children's resistance to treatment (Krysanski, 2003), and potentially, the child's reputation or identity as "the kid who does not talk" (Bunnell & Beidel, 2013). Further, as proposed by Bunnell and Beidel, "adult attention/pleas to speak often develop a paradoxical behavioral response from the child (i.e., as the adults plead with the child to speak, that attention may reinforce lack of speech)" (p. 292). Finally, children with SM often experience elevated levels of social anxiety, which may increase distress and reluctance to engage in treatment that requires exposure to feared stimuli—in this case, speaking in uncomfortable situations (see Viana et al., 2009, for a review). Meta-analytic results support behavioral intervention as the most effective approach for treating SM (Zakszeski & DuPaul, 2016), but the unique application of intervention strategies has not been well demonstrated or documented in the already sparse treatment research literature.

Successful behavioral treatment of SM includes a combination of several approaches, approximately tailored to each child with the goal of producing verbal output. The first of these often includes contingency management, where rewards are contingent upon compliance with directions from the therapist and/or caregivers (e.g., to produce verbalizations). Over time, rewards become contingent upon reaching treatment benchmarks of increasing difficulty (e.g., speaking at louder volumes and verbalizing words rather than sounds). This may be likened to rewarding successive approximations of speech, or shaping, although speaking to unfamiliar people is the "new behavior" being learned in this process. The next step is stimulus fading, or progressively introducing additional persons or settings as the child speaks to someone with whom (s)he is comfortable speaking. Continued practice and exposure to speaking with others can then be used to generalize and maintain speaking behaviors. Therapeutic tools and activities (e.g., audio/video recorders, flash cards, radios, and interactive games) that promote verbal output are commonly used as an adjunct to therapy, and can be helpful in expediting and maximizing treatment outcomes (see Bunnell, Procci, Beidel, & Bowers, 2016, for review).

Technology-based resources (e.g., smartphones, tablets) may be particularly advantageous in the behavioral treatment of SM because they provide numerous free-to-use and inexpensive apps that can be used to promote verbal output, and because children with SM are familiar with, and regularly use them (Manivannan & Fails, 2015). Thus far, two case studies have examined the utility of mobile apps in the treatment of SM (i.e., Bunnell & Beidel, 2013; Bunnell et al., 2015). The first study resulted in the successful treatment of a 17-year-old girl with SM who was previously unresponsive to pharmacological treatment and play therapy. Following limited treatment gains using exposure therapy for social anxiety (i.e., based on an extinction paradigm), the treatment plan was reconceptualized and the authors began rewarding successive approximations of speech (i.e., shifted the focus toward encouraging verbal output) while using mobile apps and a shaping hierarchy. The patient was speaking in a conversational tone and using complete sentences by the end of the first treatment session (Bunnell & Beidel, 2013). The second study replicated these findings in four children with SM. All children spoke audibly to an unfamiliar adult (i.e., the clinician) within 40 minutes of the first treatment session. All children also spoke audibly to the clinician and at least one other unfamiliar adult (M = 13 adults) during the first 14 minutes of the second treatment session (Bunnell et al., 2015). Children in both studies reported minimal anxiety levels during sessions that included the use of mobile apps.

The rapid *initial* treatment gains observed in these studies are highly encouraging, particularly because children in both studies had not spoken to unfamiliar adults or peers before treatment. However, the studies are limited by a lack of comparison to children treated using an identical shaping protocol without using mobile apps, as well as a lack of examination of mechanisms of behavior change (i.e., it is unknown *why* such rapid treatment gains occurred). It is plausible that mobile apps replace children's anxiety with positive emotions (e.g., having fun), thus enabling them to more fully engage in the shaping process (Bunnell & Beidel, 2013; Bunnell et al., 2015). In other words, that mobile apps facilitated reciprocal inhibition, the process that underlies systematic desensitization (Wolpe, 1954, 1958, 1961; Wolpe & Lazarus, 1966), allowing for faster treatment gains.

Systematic desensitization involves the elimination of an "unadaptive" response (e.g., anxiety) using an interfering competing response. This counterconditioning paradigm (Jones, 1924) postulates that a conditioned stimulus' ability to elicit a conditioned response is lost if the conditioned stimulus is paired with a new stimulus that elicits a response *incompatible* with the original conditioned response. Importantly, the incompatible response

must be stronger than the original conditioned response (Wolpe, 1968). This pairing is believed to inhibit and weaken the original conditioned response, a process which was termed "conditioned inhibition based upon reciprocal inhibition" (Wolpe, 1968). Wolpe's work led to the introduction of systematic desensitization, which involves gradual exposure to feared stimuli while simultaneously conditioning a response that is incompatible with fear (e.g., typically relaxation or feelings of happiness). This approach differs from other types of exposure therapy, which are based on extinction learning (i.e., require habituation to feared stimuli without using a competing response). The emotional processing theory of exposure therapy proposes that habituation is achieved via activation of a "fear structure," composed of a stimulus (e.g., a social situation), response (e.g., increased heart rate), and meaning associated to the stimulus (e.g., a belief that one is being socially evaluated). Once the "fear structure" is activated, corrective learning can occur via within- and between-session habituation, where the association between the stimulus and fearful responding is ameliorated. There has been much debate regarding the necessity of activation of distress and fear reduction during exposure therapy for successful treatment, and cumulating data support the contrary (see Craske et al., 2008, for review).

In theory, systematic desensitization might explain the mechanism of change during behavioral therapy for SM while using mobile apps. Specifically, pairing an emotion incompatible with anxiety during distressful situations (i.e., interactions with a stranger) might mitigate fearful responding and allow speech to occur more easily. This seems plausible given the minimal levels of anxiety reported by children in previous case studies (Bunnell & Beidel, 2013; Bunnell et al., 2015). Anecdotally, when asked about their thoughts on why they were not reporting feeling anxious, all children stated, "because I was having fun." In addition to self-report, adding the direct assessment of anxious distress during treatment using physiological measures such as heart rate variability (HRV; inter-beat interval) and electrodermal activity (EDA; galvanic skin conductance) might help to clarify the mechanisms by which mobile apps seem to exert their effect, particularly in comparison to children treated without the use of mobile apps. Therefore, the goals of this pilot study were to (a) assess behavioral change during the implementation of a two-session hierarchy for shaping successive approximations of speech in children with SM while using mobile apps, other similar therapeutic tools/activities, and reinforcement alone, and (b) begin to examine underlying mechanisms of change associated with these augmentations to the behavioral treatment of SM. It was expected that, when compared to children shaped with reinforcement alone and children shaped using other therapeutic tools, children shaped while using mobile apps would (a) complete the shaping hierarchy earlier in the session, (b) speak earlier in the session, (c) report lower levels of anxiety during treatment, and (d) exhibit lower levels of physiological anxious arousal (as measured by HRV and EDA).

Method

PROCEDURE

This study was conducted between December 2013 and October 2015, and recruitment occurred via informational flyers, provider referrals, and announcements on the Selective Mutism Association website. Following informed consent and assent, children and their caregivers completed a diagnostic interview and questionnaires assessing children's social anxiety and speaking behaviors. Children were informed that the purpose of the study was to help them to feel more comfortable speaking around other people. Children and their caregivers also were educated on the use of physiological monitoring equipment, the rationale behind the procedure, and contingency management procedures, which included rewards of $10 of monopoly money for each compliant response. After session completion, the money could be spent on prizes supplied by the clinic, and an equivalent amount could be used toward rewards from caregivers between sessions. Children were randomly assigned, using a Microsoft Excel formula, to one of three behavioral therapy groups: (a) shaping using mobile (i.e., Apple iPad) apps (*i*BT), (b) shaping using other therapeutic tools/activities (*t*BT), or (c) shaping using reinforcement alone (*r*BT).

Children sat quietly for 5 minutes at the beginning of each treatment session to establish baseline distress. After this baseline phase, data collection continued and children participated in two, $\leq$ 55-minute treatment sessions, conducted within the same week. Outcome data included children's time to complete the shaping hierarchy, latency to speak to the clinician and an additional adult, and self-reported and physiologically measured anxiety. Assessment and treatment sessions were administered by the first and second authors, who were senior doctoral students in clinical psychology. All treatment sessions were video- and audio-recorded.

PARTICIPANTS

Participants included 15 children who met DSM-5 (APA, 2013) criteria for SM (n = 5 per group). Participants ranged in age from 5 to 17 years (M = 9.6;

SD = 3.89). Exclusionary criteria included children with severe psychopathology (i.e., bipolar disorder, schizophrenia) and/or suicidal ideation. Participants with other comorbid diagnoses were not excluded. Participants taking antidepressant medications during the time of the study were included as long as they had been on a stable dose for at least 1 month prior to beginning treatment. It should be noted that Child 5 in the *r*BT group presented with a unique case of SM and social anxiety disorder (SAD) such that her withdrawal of speech and social fears were specific to speaking to adults, particularly while in the presence of her caregivers, thus her self- and caregiver-reported social anxiety fell below levels for a probable diagnosis of SAD. Despite this, the child and her caregivers insisted that social anxiety was the driving factor behind her withdrawal of speech. Similarly, Child 2 in the *i*BT group reported low levels of social anxiety, although his caregivers felt that his lack of speech was largely associated with social anxiety, as demonstrated by his elevated caregiver-reported social anxiety. Participant demographic, diagnostic, and social anxiety and SM severity data are presented in Table 1.

ASSESSMENT

Diagnostic Interview

The Anxiety Disorders Interview Schedule for DSM-IV: Child and Parent Versions (ADIS-C/P; Silverman & Albano, 1996) was administered to children and their caregivers simultaneously, and questions were adjusted to assess DSM-5 criteria when applicable. Children were not asked to speak during the interview but were asked to nod their heads (yes or no) to indicate agreement with their caregiver's response. If disagreements took place, children would whisper to their caregiver and child and caregiver would compromise on an appropriate response. None of the children spoke to the clinician during the interview.

Child- and Caregiver-Report of Children's Social Anxiety

Children and their caregivers completed the Social Phobia and Anxiety Inventory for Children (SPAI-C; Beidel, Turner, & Morris, 1995) and the SPAI-C Parent Version (SPAIC-PV; Beidel, Turner, & Morris, 2004), which each consist of 26 items that assess the frequency of anxiety symptoms during particular social situations. The SPAI-C and SPAIC-PV have demonstrated good psychometric properties (Beidel et al., 1995; Beidel, Turner, Hamlin, & Morris, 2000; Bunnell et al., 2015; Higa, Fernandez, & Nakamura, 2006). For younger children who experienced difficulty with reading, caregivers assisted in reading SPAI-C questions.

Caregiver Report of Children's Speaking Behavior

The Selective Mutism Questionnaire (SMQ; Bergman et al., 2008) is a caregiver-reported measure of children's speaking behaviors. The SMQ consists of

Table 1
Demographic, Diagnostic, and Symptom Severity Data

Group	Child	Age	Sex	Race	Diagnoses	SPAI-C *M* [95% CI]	SPAIC-PV *M* [95% CI]	SMQ *M* [95% CI]
*i*BT	1	9	M	White	SM, SAD	23	14	1.18
	2	16	M	White	SM, SAD, SepAnx	9	40	1.00
	3	13	F	White	SM, SAD	41	33	1.13
	4	9	F	White	SM, SAD, GAD	38	43	0.88
	5	6	F	Latina	SM, SAD	16	16	1.88
	Group					**25.40 [13.28, 37.52]**	**29.20 [17.38, 41.02]**	**1.21 [0.87, 1.56]**
*t*BT	1	10	F	White	SM, SAD	41	38	0.88
	2	5	M	Latino	SM, SAD	46	46	0.60
	3	16	F	Latina	SM, SAD	28	43	0.88
	4	11	F	White	SM, SAD	39	42	0.63
	5	5	F	Latina	SM, SAD, Enuresis	38	36	1.19
	Group					**38.40 [32.63, 44.17]**	**41.00 [37.49, 44.51]**	**0.83 [0.62, 1.04]**
*r*BT	1	15	F	Latina	SM, SAD	44	45	0.69
	2	5	M	Black	SM, SAD, SepAnx	36	40	0.80
	3	8	M	White	SM, SAD, Enuresis	30	28	1.13
	4	7	F	White	SM, SAD	30	41	0.69
	5	9	F	White	SM, SAD	13	14	1.81
	Group					**30.60 [20.61, 40.59]**	**33.60 [22.50, 44.70]**	**1.02 [0.60, 1.44]**

Note. SM = Selective Mutism; SAD = Social Anxiety Disorder; SepAnx = Separation Anxiety Disorder; GAD = Generalized Anxiety Disorder; *M* = Mean; 95% CI = 95% Confidence Interval; SPAI-C = Social Phobia and Anxiety Inventory for Children; SPAIC-PV = Social Phobia and Anxiety Inventory for Children – Parent Version; SMQ = Selective Mutism Questionnaire; Scores ≥ 18 on the SPAI-C and SPAIC-PV reflect clinically elevated levels of social anxiety.

17 items for which caregivers rate the frequency of their child's speech in three settings (i.e., Home, School, and Other). Items are rated on a 4-point Likert scale (0 = *Never*, 1 = *Seldom*, 2 = *Often*, 3 = *Always*), and are averaged to provide a total score, with lower total scores indicating higher SM severity and impairment. The SMQ has been validated and has demonstrated good psychometric properties (Bergman et al., 2008).

Behavioral Assessment

Children's latency to complete the shaping hierarchy, speak to the clinician, and speak to an additional unfamiliar adult after being prompted were recorded and coded using the Noldus Behavioral Observation System XT (Noldus Information Technology, 2015). Children reported their anxiety levels using a pictorial and numeric 5-point Likert scale (0 = *No Anxiety*; 1 = *Mild Anxiety*; 2 = *Moderate Anxiety*; 3 = *Severe Anxiety*; 4 = *Extreme Anxiety*) at 5-minute intervals during baseline and treatment.

Physiological Assessment of Anxious Arousal

Indicators of physiological anxious arousal included HRV and EDA. HRV is the variation between heart beats (i.e., inter-beat-interval), and is an indicator of autonomic regulation or flexibility (i.e., the interplay between sympathetic and parasympathetic activation; Billman, 2011). Increases in HRV occur when individuals are in a calm or relaxed state, which is indicative of increased parasympathetic activity. Conversely, decreases in HRV are observed when an individual is experiencing high levels of distress such that parasympathetic activity is inhibited (e.g., a "fight or flight" response). These trends have been particularly noted for individuals attempting to regulate emotions during stressful social interactions (Porges, 2007). EDA is a direct measure of sympathetic activation and has been successfully measured in youths with SAD and SM during distressing social interactions (Mesa, Beidel, & Bunnell, 2014; Young, Bunnell, & Beidel, 2012).

Physiological anxious arousal was recorded and measured using the Mindware BioLab Acquisition Software and Ambulatory System (Mindware Technologies, LTD, 2009). This ambulatory equipment allows for simultaneous and continuous collection of data (i.e., approximately 500 samples per second) using a small ambulatory unit, which transmits the data wirelessly to a computer for digital storage and analysis. Data were examined juxtaposed to a synced video recording of the treatment sessions using Noldus and exported to Microsoft Excel.

TREATMENT

All children were shaped using the same hierarchy (see Table 2), with the *i*BT group including the use of mobile apps (column 3), the *t*BT group including the use of other tools similar to each step's respective mobile app (e.g., bubbles, pinwheels, flash cards, sound recorders; column 4), and the *r*BT including reinforcement after emitting the target behavior as instructed, without the inclusion of specific activities, tools, or devices (column 5). Children remained in the session until completion of the hierarchy, or until the session length reached 55 minutes, the rationale for the latter being the low likelihood that community clinicians will be able to hold treatment sessions longer than this length of time. In two cases (i.e., Child 3 in the *i*BT group and Child 2 in the *t*BT group), this was not possible due to variable consistency in the children's level of response to requests from the clinician, the eventual withdrawal of compliant responses, and concerns about continuing to provide attention for noncompliant responses. Children were rewarded with $10 of monopoly money for each compliant response during sessions, which was added at the end of the session and spent on prizes from the clinician (e.g., small toys and stickers), and also a reward from the child's caregiver (e.g., money to be put towards a game or toy, extra television time, later bedtimes).

Session 1 began with rewards for successive approximations of speech and ended with children asking and responding to open-ended questions. Children were required to complete each step of the hierarchy successfully a minimum of five times to advance to the next step. The procedure, behavior to emit, and treatment goal for each step of the hierarchy were the same for each group, although there were variations in the exact verbiage used at each step. The procedure, with example verbiage used during Step 16 for the *i*BT group, included: (1) a brief overview of the app, tool, or behavior to emit (e.g., "This is the Monsters app. You can record what you say and the monsters will say it back to you in a funny voice!"); (2) a physical demonstration by the clinician (e.g., "Watch while I try it," [clinician records voice and plays it back for the child], "See how fun that is?"); (3) an explanation of the specific behavior to emit and the reward that would follow (e.g., "This time, I want you to ask me an open-ended question, I will answer and ask you the same question back, and I will give you $10 of monopoly money for each question and answer that you give"); (4) a prompt to emit the behavior (e.g., "Ok, your turn, go ahead and ask me a question"); (4a) a reminder of potential rewards for children showing reluctance (e.g., "I know it may be hard, but don't forget about all of the fun prizes that you can earn after we are done today!"); (4b) an example of an open-ended question for children who struggled to come up

Table 2
Two-Session Shaping Hierarchy with Mobile Apps and Therapeutic Tools

Session	Step	Mobile App	Other Tool	Behavior to Emit	Treatment Goal
1	1	Free Candle	Blow Bubbles	Blow once	Emit audible sound
	2	Free Candle	Blow Bubbles	Blow with increased pressure	Emit audible sound at increased volume
	3	Free Candle	Blow Bubbles	Blow at increased frequency (≤5)	Emit multiple audible sounds at increased volume
	4	Blowing Game	Pinwheel	Blow loudly and repeatedly	Emit multiple audible sounds at increased volume
	5	Yes/No Fun Deck	Yes/No Flashcards	Blow in response to close-ended questions	Emit audible sounds while responding to questions
	6	Talking Gina	Voice Recorder	Blow "O" sounds	Begin to emit audible verbalizations
	7	Talking Gina	Voice Recorder	Blow "U" sounds	Continue to emit audible verbalizations
	8	Talking Gina	Voice Recorder	Blow vowel sounds	Increase the number of audible verbalizations
	9	Meet the Vowels	Flash Cards	Whisper vowels	Continue to practice emitting audible verbalizations
	10	Meet the Letters	Flash Cards	Whisper letters including consonants	Increase the number of audible verbalizations
	11	Meet the Words	Flash Cards	Whisper words	Begin to verbalize words
	12	Meet the Words	Flash Cards	Verbalize words with increased volume	Increase the volume of verbalized words
	13	Camstar	Disposable Camera	Say the names of items photographed	Generalize speaking to items rather than written words
	14	Yes/No Fun Deck	Yes/No Flashcards	Say yes or no to questions asked	Respond verbally to close-ended questions
	15	Monsters	Voice Recorder	Respond to open ended questions	Respond verbally to open-ended questions
	16	Monsters	Voice Recorder	Ask and respond to open ended questions	Verbalize questions for others to answer
2	1	Monsters	Voice Recorder	Ask and respond to open ended questions with additional adults	Verbalize questions for others to answer

Note. Children were required to complete each step of the hierarchy a minimum of 5 times before moving to the next step.

with one on their own (e.g., "Let's try, what is your favorite color?"); and (4) praise and provision of $10 of monopoly money following the child's response (e.g., "You did it! Great job asking me a question and answering mine! Here is $10 of monopoly money."). This procedure was repeated five times before repeating it again during the next step.

Session 2 included five, 5-minute conversations with unfamiliar adults (i.e., research assistants), during which children were rewarded with $10 of monopoly money each time they spoke to the adult. The procedure for conversations were as follows: (1) the unfamiliar adult entered the room, was introduced by the clinician, and provided a greeting to the child; (2) the child was rewarded for greeting the adult, or encouraged to do so if no greeting was given, and was rewarded with $10 of monopoly money afterwards; (3) the child was instructed to ask the adult an open-ended question (assistance was provided throughout the conversation as needed; see 4a and 4b above), the adult provided a response and the child received praise and $10 of monopoly money; and (4) the adult asked the same question back to the child, who was rewarded with praise and $10 of monopoly money after responding. This process continued using different open-ended questions for a total of five minutes, after which the adult said goodbye to the child, who was rewarded for providing a farewell in response. The procedure then was repeated with four additional adults during separate five-minute conversations. Each statement made during these conversations was recorded and played using a mobile app, for children in the *i*BT group, or a voice recorder, for children in the *t*BT group (see Table 2).

Results

DATA ANALYSIS

Session recordings and physiological data were imported into Noldus. Baseline and treatment phases

were coded as well as time until completion of the shaping hierarchy, children's latency to speak to the clinician—operationalized as either whispering or saying a complete word, and latency to speak to an additional unfamiliar adult after being prompted to do so. Data then were compared descriptively among groups using 95% confidence intervals (CIs). Child-reported anxiety was assessed in-session by the clinician and change scores were calculated by subtracting baseline ratings from averaged scores from treatment. Children's anxiety ratings at the time of first speech also were recorded and compared among groups. HRV and EDA (i.e., skin conductance level in microsiemens) were averaged for each minute of each session.

Small *n* Statistics software (Gilroy, 2015) was used to compare baseline and treatment HRV and EDA data for each participant using the following recommended metrics for single case research. Hedge's g* (Hedges, 1981) is an effect size measure that adjusts for the upward bias of smaller sample sizes (i.e., does not assume equal variances). Percentage of All Non-Overlapping Data statistic (PAND) measures the percentage of all data points that do not overlap between baseline and treatment phases (Parker, Hagan-Burke, & Vannest, 2007).

BEHAVIORAL ASSESSMENT

Hierarchy Completion and Speaking Behavior

Thirteen of 15 children (86.67%) completed the shaping hierarchy during Session 1 (i.e., asked and responded to five open-ended questions), and 14 (93.33%) completed the hierarchy by the end of Session 2. Child 3 in the *i*BT group ceased responding during Session 1, but completed the hierarchy within 24 minutes of the beginning of Session 2. Notably, Child 2 in the *t*BT group, the youngest participant in the sample, completed Step 15 of the hierarchy by the end of Session 2. Children's latency to complete the hierarchy ranged from 14 to 71 minutes of treatment (M = 34.54, 95% CI [20.70, 48.37]). The average latency to complete the hierarchy was similar across groups, as evidenced by overlapping 95% CIs, with the *r*BT group completing the hierarchy approximately 3 to 4 minutes before the *t*BT and *i*BT groups (Table 3).

All 13 children who completed the hierarchy during Session 1 spoke to the clinician within 22 minutes. Child 3 in the *i*BT group spoke within 45 seconds of the beginning of Session 2, and Child 2 in the *t*BT group spoke within 16 minutes. Thus, all 15 children spoke to the clinician within 59 minutes of treatment. The average latency to speak to the clinician for all groups fell between 10.56 and 21.12 minutes (M = 17.42, 95% CI [3.73, 31.12]), a range of approximately 11 minutes. This latency was approximately 10–11 minutes higher for children in the *i*BT and *t*BT groups. Of the 14 children who spoke to an additional unfamiliar adult, all did so within 97.76 seconds of being prompted. The average latency for each group

Table 3
Behavioral Assessment of Hierarchy Completion and Speaking Behavior

Group	Child	Latency to Complete Hierarchy (in minutes) *M* [95% CI]	Latency to Speak to Clinician (in minutes) *M* [95% CI]	Latency to Speak to Additional Adult Following Prompt (in seconds) *M* [95% CI]
*i*BT	1	37.81	22.05	11. 80
	2	25.86	13.48	14.54
	3	71.18[a]	48.17[a]	67.64
	4	23.55	5.04	20.29
	5	23.53	14.15	97.76
	Group	**36.39 [18.56, 54.21]**	**20.58 [6.06, 35.09]**	**50.06 [15.24, 84.87]**
*t*BT	1	37.36	11.23	18.35
	2	- [b]	59.16[a]	- [b]
	3	22.32	8.18	44.05
	4	39.52	11.00	73.47
	5	43.40	16.05	3.77
	Group	**35.65 [26.60, 44.70]**	**21.12 [2.32, 39.93]**	**34.91 [4.89, 64.93]**
*r*BT	1	54.19	10.80	13.75
	2	47.35	20.08	29.59
	3	19.02	6.95	25.06
	4	23.99	8.83	23.86
	5	14.41	6.17	24.89
	Group	**31.79 [16.17, 47.41]**	**10.57 [5.65, 15.49]**	**23.43 [18.31, 28.55]**
	All	**34.54 [20.70, 48.37]**	**17.42 [3.73, 31.12]**	**35.16 [10.81, 59.50]**

Note. M = Mean; 95% CI = 95% Confidence Interval; [a] = Behavioral goal reached during Session 2; [b] = Behavioral goal was not reached by the end of Session 2.

ranged from 23.43 to 36.09 seconds. All 14 of these children participated in the planned five, 5-minute conversations with unfamiliar adults (Table 3).

Child-Reported Anxiety

With respect to self-reported levels of anxiety, children in the *i*BT group tended to report lower and less variable ratings of anxiety in both sessions. The average rating during Session 1 for children in this group was 1.58 (*SD* = 0.75, 95% CI [0.92, 2.23]), compared to 2.68 (*SD* = 0.91, 95% CI [1.78, 3.57]) and 2.23 (*SD* = 1.23, 95% CI [1.15, 3.30]) for the *t*BT and *r*BT groups, respectively. The average rating during Session 2 for children in the *i*BT group was 1.46 (*SD* = 0.64, 95% CI [0.91, 2.02]), compared to 2.61 (*SD* = 1.37, 95% CI [1.26, 3.95) and 1.77 (*SD* = 1.21, 95% CI [0.71, 2.83]) for the *t*BT and *r*BT groups, respectively. All children in the *i*BT group reported mild to moderate levels of anxiety (≤ 3), whereas children in the *t*BT and *r*BT groups reported maximum ratings between 4 and 5.

With respect to individual ratings of anxiety, four children (i.e., two in the *t*BT group and two in the *r*BT group) reported anxiety ratings above baseline levels during the first session. Children in the *i*BT group did not report ratings above their initial baseline anxiety ratings during this session, suggesting no increase in anxiety as a result of treatment demands to begin speaking. During Session 2, a similar pattern was observed with the exception that one child in the *i*BT group reported ratings above baseline, although it should be noted that the child from this group was the only child to return back to baseline levels by the end of the session.

Children's baseline anxiety ratings were subtracted from averaged anxiety ratings from each session, with positive and negative values indicating average increases and decreases from baseline, respectively. Two children in the *t*BT group and one child in the *r*BT group exhibited average increases in anxiety from baseline during Session 1. All other children exhibited either average decreases or no average change in anxiety from baseline. On average, each group exhibited mean decreases in anxiety from baseline, with the *i*BT group demonstrating the largest decrease, and the *t*BT and *r*BT groups following suit. Although differences were in the expected directions, they were minimal with overlapping CIs (see Figure 1).

In contrast to Session 1, average decreases in anxiety from baseline were not observed for Session 2. Two children from each group exhibited a mean increase from baseline. On average, each group exhibited mean increases in anxiety from baseline. A similar pattern to Session 1 was observed such that the *i*BT group demonstrated the smallest average increase with the *t*BT and *r*BT groups following in suit. Again, differences were in the expected directions but were minimal with overlapping CIs (see Figure 2).

Anxiety ratings were recorded at the time of each child's first audible word to the clinician during the first session. As demonstrated in Figure 3, anxiety ratings following initial speech to the clinician were lowest for the *i*BT group (*M* = 1.4, *SD* = 0.55, 95% CI [0.92, 1.88]) in comparison to the *t*BT (*M* = 2.2, *SD* = 0.84, 95% CI [1.47, 2.93]) and *r*BT (*M* = 2.2, *SD* = 1.14, 95% CI [1.06, 3.34]) groups. However, differences were minimal with overlapping CIs.

Physiologically Measured Anxious Arousal

Although the results of analyses of HRV largely followed similar patterns to those of self-reported anxiety, within- and between-group differences were minor and all CIs for Hedge's g* overlapped. During Session 1, children in the *i*BT group exhibited a 0.09 standard deviation decrease in HRV from baseline to treatment, compared to

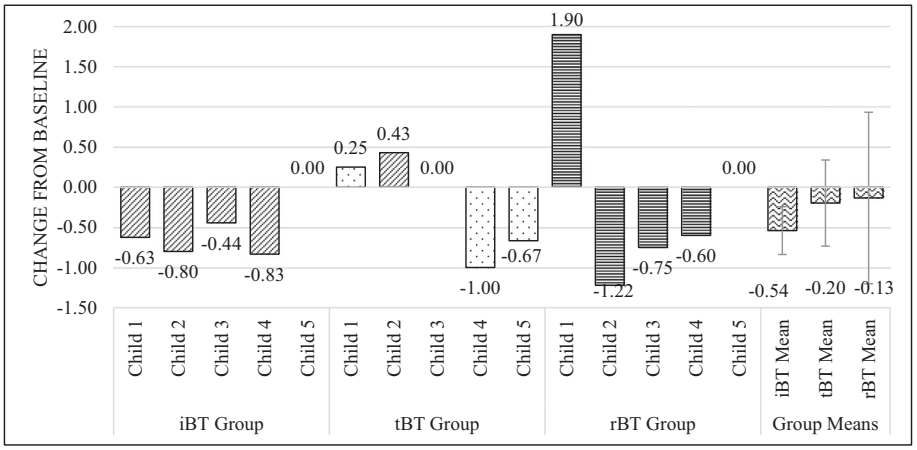

FIGURE 1 Average Self-Reported Anxiety Ratings in Relation to Baseline Ratings for Session 1

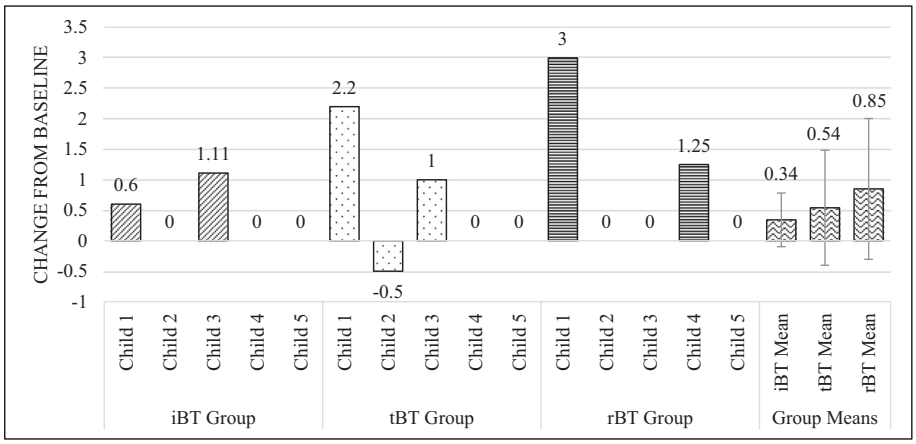

FIGURE 2 Average Self-Reported Anxiety Ratings in Relation to Baseline Ratings for Session 2

children in the *t*BT and *r*BT groups, whose HRV decreased by 0.19 and 0.21, respectively. On average, children in the *i*BT group demonstrated a 68.35% mean nonoverlap in HRV between baseline and treatment compared to the *t*BT and *r*BT groups, whose mean nonoverlap was 83.29% and 72.65%, respectively. During Session 2, children in *i*BT and *r*BT groups exhibited 0.15 standard deviation decreases in HRV, and the *t*BT group's HRV decreased by 0.08 standard deviations. Children in the *i*BT group demonstrated the smallest mean nonoverlap in HRV between baseline and treatment (i.e., 53.88% *vs*. 70.41% and 81.83% for the *t*BT and *r*BT groups, respectively), suggesting the least change from baseline (see Table 4).

Results of analyses of EDA for Session 1 were somewhat similar to those of HRV in that children in the *i*BT group exhibited a 0.50 standard deviation increase in EDA from baseline to treatment whereas those the *r*BT group showed a 1.49 standard deviation increase, however, children in the *t*BT group exhibited an increase similar to the *i*BT group (i.e., a 0.46 standard deviation increase). This pattern was not observed with respect to nonoverlap of EDA values between baseline and treatment. Specifically, children in the *i*BT group demonstrated a 98.19% nonoverlap compared to the *t*BT and *r*BT groups, whose data showed nonoverlap of 87.95% and 98.76%, respectively. The results of analyses of EDA for Session 2 also were somewhat similar to those observed for HRV in that children in the *t*BT group exhibited the smallest standard deviation increase in EDA between baseline and treatment (i.e., 0.85 *vs*. 1.33 and 1.44 for the *i*BT and *r*BT groups, respectively), although these differences between groups were more pronounced. Mean nonoverlap in EDA from baseline to treatment was similar

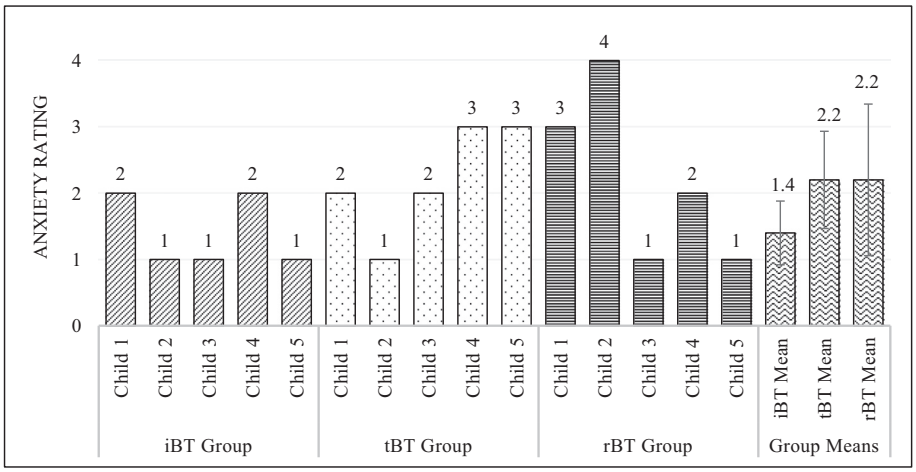

FIGURE 3 Self-Reported Anxiety Following Initial Speech

Table 4
HRV During Shaping Sessions

Group	Child	Baseline HRV *M* (*SD*) [95% CI]	Treatment HRV *M* (*SD*) [95% CI]	Hedges' g* [95% CI]	PAND *M*
Session 1					
*t*BT	1	759.22 (21.17)	744.24 (46.76)	-0.30	56.25
	2	1193.64 (69.59)	1068.21 (115.70)	-1.02	87.88
	3	937.85 (27.92)	908.35 (31.96)	-0.84	77.36
	4	703.14 (45.46)	728.16 (84.89)	0.28	37.50
	5	618.70 (24.72)	658.81 (30.22)	1.23	82.76
	Group	**842.51 [642.23, 1042.79]**	**821.55 [676.49, 966.62]**	**-0.09 [-1.34, 1.15]**	**68.35**
*t*BT	1	677.24 (17.80)	645.32 (26.86)	-1.10	85.18
	2	660.20 (23.22)	607.68 (39.19)	-1.24	81.25
	3	684.01 (21.08)	706.30 (38.22)	0.55	75.86
	4	925.97 (17.04)	851.31 (32.37)	-2.15	95.74
	5	611.28 (10.67)	629.26 (24.84)	0.67	78.43
	Group	**711.74 [591.12, 832.36]**	**687.97 [591.55, 784.40]**	**-0.19 [-1.43, 1.05]**	**83.29**
*t*BT	1	836.44 (31.94)	794.18 (45.10)	-0.86	60.00
	2	702.64 (17.17)	717.53 (32.10)	0.43	67.27
	3	674.08 (10.84)	658.76 (18.00)	-0.81	74.07
	4	576.14 (14.32)	515.90 (18.06)	-3.09	100.00
	5	671.98 (17.99)	663.31 (29.90)	-0.28	61.90
	Group	**692.26 [610.12, 774.39]**	**669.94 [580.55, 759.32]**	**-.021 [-1.45, 1.04]**	**72.65**
Session 2					
*t*BT	1	815.53 (24.43)	777.05 (36.14)	-0.99	63.89
	2	1011.93 (66.49)	980.17 (43.61)	-0.61	47.06
	3	929.95 (32.60)	934.48 (42.08)	0.10	32.00
	4	725.54 (40.36)	685.97 (28.37)	-1.18	70.59
	5	700.69 (6.86)	691.66 (24.92)	-0.35	55.88
	Group	**836.73 [720.19, 953.26]**	**813.87 [693.96, 933.77]**	**-0.15 [-1.39, 1.09]**	**53.88**
*t*BT	1	678.74 (9.07)	661.94 (10.34)	-1.49	79.41
	2	578.73 (20.02)	555.80 (19.55)	-1.06	72.00
	3	698.09 (21.64)	685.18 (22.19)	-0.53	73.68
	4	827.52 (22.28)	820.76 (32.90)	-0.19	57.50
	5	584.36 (9.34)	598.02 (12.00)	1.05	69.44
	Group	**673.49 [573.93, 773.04]**	**664.34 [565.02, 763.66]**	**-0.08 [-1.32, 1.16]**	**70.41**
*t*BT	1	953.50 (13.81)	892.02 (22.98)	-2.50	97.56
	2	676.86 (24.60)	715.32 (33.48)	1.07	75.00
	3	697.68 (31.51)	660.70 (16.63)	-1.80	88.89
	4	583.71 (25.37)	553.41 (11.59)	-1.91	94.77
	5	738.74 (25.05)	719.70 (15.79)	-0.10	52.94
	Group	**730.10 [609.84, 850.36]**	**708.23 [600.71, 815.75]**	**-0.15 [-1.39, 1.09]**	**81.83**

Note. HRV = Heart Rate Variability; *M* = Mean; *SD* = Standard Deviation; 95% CI = 95% Confidence Interval; PAND = Percentage of All Non-Overlapping Data.

among groups (i.e., mean nonoverlap was between 98.12 and 99.62; see Table 5).

Discussion

Treating SM is often difficult. Factors that inform the behavioral conceptualization of SM and contribute to its development and maintenance (e.g., reinforcement for not speaking, children's resistance to treatment, and frequently accompanying social anxiety) should be targeted as a part of treatment. Meta-analytic results support behavioral intervention as the most effective treatment (Zakszeski & DuPaul, 2016), but the unique application of specific intervention strategies is not always clear to community clinicians. Therapeutic tools and activities (e.g., interactive games and sound recorders) that promote verbal output are often used during behavioral therapy to help expedite and maximize treatment outcomes, and the use of technology such as smartphones and tablets may provide particular advantages (Bunnell & Beidel, 2013; Bunnell et al., 2015). In addition to convenience and applicability, the use of mobile devices may promote treatment engagement (Manivannan & Fails, 2015), perhaps through mechanisms such as systematic desensitization/

Table 5
EDA During Shaping Sessions

Group	Child	Baseline EDA *M* (*SD*) [95% CI]	Treatment EDA *M* (*SD*) [95% CI]	Hedges' g* [95% CI]	PAND *M*
Session 1					
*t*BT	1	17.70 (1.47)	19.42 (1.13)	1.47	97.04
	2	4.02 (0.14)	6.51 (0.45)	5.91	100.00
	3	6.79 (0.62)	11.64 (1.36)	3.68	98.86
	4	2.67 (0.30)	6.38 (1.04)	3.83	100.00
	5	6.92 (0.89)	9.68 (1.19)	2.42	95.03
	Group	**7.62 [2.43, 12.81]**	**10.73 [6.04, 15.41]**	**0.50 [-0.76, 1.76]**	**98.19**
*f*BT	1	4.80 (0.70)	6.60 (1.16)	1.59	87.26
	2	20.38 (1.45)	22.41 (1.68)	1.23	83.73
	3	5.54 (0.66)	6.38 (1.01)	0.87	73.84
	4	8.04 (3.00)	17.51 (1.21)	6.29	99.96
	5	10.26 (0.93)	12.63 (0.97)	2.44	94.97
	Group	**9.80 [3.64, 15.97]**	**13.10 [6.28, 19.92]**	**0.45 [-0.81, 1.70]**	**87.95**
*r*BT	1	6.70 (1.16)	14.44 (1.57)	5.03	100.00
	2	7.17 (0.64)	11.89 (1.64)	3.00	99.60
	3	11.43 (1.24)	14.56 (0.85)	3.35	96.63
	4	13.42 (0.80)	15.96 (0.64)	3.77	97.63
	5	12.73 (0.45)	15.04 (0.49)	4.80	99.92
	Group	**10.29 [7.53, 13.05]**	**14.38 [13.05, 15.70]**	**1.49 [0.09, 2.90]**	**98.76**
Session 2					
*t*BT	1	9.34 (0.70)	13.99 (0.61)	7.17	99.38
	2	6.15 (0.16)	7.91 (0.29)	6.43	100.00
	3	5.13 (0.45)	9.83 (1.34)	3.68	99.73
	4	7.96 (1.96)	20.27 (1.67)	7.15	100.00
	5	5.61 (0.87)	9.63 (1.67)	2.55	96.82
	Group	**6.84 [5.29, 8.38]**	**12.33 [7.97, 16.68]**	**1.33 [-0.04, 2.70]**	**99.19**
*f*BT	1	5.22 (0.40)	8.11 (0.49)	6.06	100.00
	2	14.56 (1.98)	20.06 (2.61)	2.15	92.72
	3	4.28 (0.84)	6.93 (0.67)	3.79	97.89
	4	9.79 (1.14)	17.97 (1.09)	7.43	100.00
	5	12.38 (1.60)	19.12 (0.77)	7.21	100.00
	Group	**9.25 [4.88, 13.61]**	**14.44 [8.19, 20.68]**	**0.85 [-0.44, 2.15]**	**98.12**
*r*BT	1	4.91 (1.06)	12.76 (2.72)	3.04	100.00
	2	11.41 (0.62)	20.14 (1.92)	4.86	100.00
	3	12.73 (0.79)	16.81 (0.60)	6.54	100.00
	4	7.99 (1.05)	11.70 (1.03)	3.58	98.91
	5	7.82 (0.67)	11.24 (1.16)	3.11	99.21
	Group	**8.97 [6.24, 11.70]**	**14.53 [11.17, 17.89]**	**1.44 [0.05, 2.83]**	**99.62**

Note. EDA = Electrodermal Activity; *M* = Mean; *SD* = Standard Deviation; 95% CI = 95% Confidence Interval; PAND = Percentage of All Non-Overlapping Data.

reciprocal inhibition (Wolpe, 1968), where enjoyment or pleasure, rather than anxiety or fear, are paired with speaking in uncomfortable social situations.

The goals of this small pilot study were to (a) assess behavioral change during the implementation of a two-session hierarchy for shaping successive approximations of speech in children with SM while using mobile apps, other similar therapeutic tools/activities, and reinforcement alone, and (b) begin to examine underlying mechanisms of change associated with these treatment augmentations. The results of this study are encouraging, despite tenuous conclusions relating to the proposed hypotheses. With respect to hierarchy completion, 13 (86.67%) of the 15 children enrolled in the study completed the shaping hierarchy, and thus were speaking audibly during the first treatment session. Fourteen (93.33%) completed the hierarchy by the end of the second session (i.e., within 71 minutes of treatment). Notably, the 1 child who did not complete the entire hierarchy completed all but the final step (i.e., to ask and respond to at least five open-ended questions with the clinician) by the end of the second session. Overall, differences in children's latency to hierarchy completion were

not observed among groups, as evidenced by overlapping 95% CIs. Further, although the *r*BT group completed the hierarchy slightly earlier than the other two groups, a mean difference of 3 to 4 minutes is unlikely to have any clinical significance. Regarding speaking behavior, all 15 children included in the study spoke to the clinician within 59 minutes of treatment, with an average latency of 17 minutes. Group differences were again minimal, with overlapping 95% CIs, and likely insignificant from a clinical standpoint. Finally, 14 (93.33%) children engaged in five, 5-minute conversations with unfamiliar adults—with some assistance from the clinician to develop questions—during the second treatment session.

Taken together, the results of previous studies (i.e., Bunnell & Beidel, 2013; Bunnell et al., 2015) were replicated. To the best of our knowledge, aside from the case presentation by Bunnell and colleagues (2015), no other studies have reported the elicitation of speech within the first session of the treatment of SM for multiple children, particularly across such a wide age range. Moreover, this study reported that children spoke to multiple unfamiliar adults during the second session. These results require replication with larger samples and, perhaps, in combination with other evidence-based, but more comprehensive interventions for SM (e.g., Bergman, Gonzalez, Piacentini, & Keller, 2013). These data also align with prior literature suggesting that behavioral strategies are most effective for treating SM, and demonstrate specifically that the use of a structured shaping hierarchy and specific contingency management protocol may result in early verbalization. This may occur regardless of the tools or activities with which they are administered, although understanding the specific mechanisms of change during treatment is still of great importance (Kazdin & Nock, 2003).

With respect to child-reported anxiety during treatment, patterns of responding were in expected directions, although minimal with overlapping 95% CIs. Children in the *i*BT group consistently *reported* lower and less variable levels of anxiety during each session compared to children in the other groups. The maximum anxiety rating for this group fell within the mild to moderate range (≤ 3), whereas maximum ratings for the other groups fell within the severe and extreme ranges. Consistent patterns also were observed for children's average anxiety ratings in relation to baseline ratings, such that children in the *i*BT group indicated larger decreases in anxiety during the first session and smaller increases in anxiety during the second session compared to children in the other groups. This pattern also held true when examining children's report of anxiety following initial speech to the clinician (i.e., children in the *i*BT group reported lower levels of distress after speaking to the clinician for the first time). These data were consistent with prior work, and suggest that children's subjective experience of anxiety during treatment might be mitigated when mobile apps, as opposed to other therapeutic activities and reinforcement alone, are used.

Given SM's reclassification as an anxiety disorder in the DSM-5 (APA, 2013) and the high rates of social anxiety typically reported by children with SM, finding ways to engage these children in therapy using a treatment modality that encourages speech while eliciting limited subjective anxious distress may be important. Granted, not all children with SM meet criteria for SAD. Some might be better classified as anxious–communication delayed or anxious–mildly oppositional (Cohan et al., 2008), and others might simply be exhibiting oppositional behaviors (although these findings are mixed; Viana et al., 2009). Despite debate over etiology and comorbidity, it is plausible that a structured and outlined shaping hierarchy and specific contingency management protocol that makes use of tools that cause *little-to-no distress* in these children may be useful as treatments for SM are further refined.

The results from the assessment of physiological anxious distress during treatment largely followed the patterns observed for child-reported anxiety but, again, group differences were minimal with overlapping CIs. Specifically, children in the *i*BT group tended to exhibit smaller standard deviation decreases and less nonoverlap in HRV from baseline during the first session, and less nonoverlap in HRV from baseline during the second session. Although caution in interpretation is needed, this suggests a trending pattern of better *regulation* of anxious arousal in children in the *i*BT group. The HRV results were consistent with EDA data, such that children in the *i*BT and *t*BT groups exhibited smaller increases in EDA during the first session, compared to those in the *r*BT group (i.e., a one standard deviation difference), and similar patterns were observed for nonoverlap of EDA between baseline and treatment. This suggested less sympathetic activation (i.e., anxious arousal) for children shaped using mobile apps and other therapeutic tools compared to those shaped with reinforcement alone. Changes in EDA during the second session suggested that children in the *t*BT group tended to show smaller increases in EDA from baseline to treatment. Interestingly, for both sessions, the 95% CIs for standard deviation changes in EDA from baseline included negative

values for the *i*BT and *t*BT groups, whereas only positive values were included for the *r*BT group.

Collectively, while requiring replication with a larger sample, physiological assessment data suggest patterns of more controlled and less anxious responding in children shaped using mobile apps and other therapeutic tools compared to reinforcement alone. It should be noted that there are factors that might influence results of physiological assessment. For example, EDA is associated with several emotional response patterns, including negative emotions such as fear, anxiety, and embarrassment, but also positive emotions such as amusement, happiness, and pleasure (Kreibig, 2010). This confound can make it difficult to differentiate between anxious and pleasurable responding (i.e., either due to enjoyment from activity or positively reinforcing stimuli) in these children based solely on EDA response. That being said, the examination of HRV and child-reported anxiety strengthens this approach as it allows for a more specific analysis of anxious responding, particularly in relation to social anxiety or distress (Porges, 2007). Patterns of self-reported anxious distress and changes in HRV suggested that children tend to experience less anxious distress when mobile apps are included, at least during initial administration of the shaping hierarchy.

Although requiring cautious interpretation, the data suggest that shaping speech while using mobile apps can be effective and supports the notion that the potential mechanism of change is systematic desensitization. Although the results suggested that children with SM respond similarly with respect to hierarchy completion and speaking behavior, regardless of modality of delivery, there may be additional benefits to using mobile apps that have yet to be examined. For instance, having numerous therapeutic activities in a mobile device might be particularly advantageous, especially as "digital technologies play an important role in young children's lives, and they generally embraced them with enthusiasm and pleasure" (Chaudron et al., 2015; p. 24). Further, mobile devices are likely to be readily available to clinicians across a wide range of settings (i.e., over approximately 75% of the U.S. population owns a smartphone; Smith, 2017). Perhaps the most clinically significant finding relates to rapid treatment gains observed as a result of using this particular shaping hierarchy, and data suggesting the experience of minimal distress while using mobile apps. Given common difficulties with treatment and the many facets of SM that should be targeted as a part of treatment, having an established procedure for reinforcing speech early in the treatment process may be of great value, especially during the beginning stages of treatment.

This study has several limitations that provide opportunities for future work in this area. First, this study made use of a single case design strategy with a randomized assignment to treatment groups. Although this design was appropriate for the question at hand, a larger randomized controlled trial would allow for more powerful statistical comparisons. The small sample included in this study limited the ability to test group differences statistically. Difficulty with recruitment in this population is well-noted with published investigations examining the treatment of SM traditionally having included small samples (e.g., $N = 21$ and 24 for Bergman et al., 2013, and Oerbeck et al., 2014, respectively), and is likely due to the low prevalence of the disorder (i.e., $\leq 1\%$). Second, this study only included conversations with unfamiliar adults *vs.* conversations with similarly aged peers or familiar adults with whom children were uncomfortable speaking. This was due to budget limitations and barriers to scheduling treatment appointments with multiple adults and youths with whom the child was familiar. Although all children and caregivers in this study reported that the children experienced difficulties with speaking to unfamiliar adults, this is not always the case in children with SM and, thus, the generalizability of results are limited to interactions with a new clinician and unfamiliar adults. Third, it should be clearly noted that the protocol presented in this study is not intended as a comprehensive treatment for SM. The shaping hierarchy provided should be viewed as a useful tool during the initial stages SM treatment, to promote speech early in treatment in hopes of potentially decreasing the time needed to begin to make initial therapeutic gains. Further intervention is needed past these two sessions, as results are unlikely to generalize to the child's natural environment without repeated practice. As noted by Beidel and Turner (2007), after children with SM and SAD are able to consistently produce speech following behavioral shaping of verbalizations, they may then go on to successfully participate in continued evidence-based intervention for SAD (e.g., Social Effectiveness Therapy for Children; Beidel, Turner, & Morris, 2000), which aims to decrease social anxiety and increase the frequency and effectiveness of socialization. Relatedly, a fourth limitation is that although continued treatment was provided by the authors at no cost to participants, treatment approaches after the initial two sessions were not standardized. Anecdotally, children who regularly engaged in follow-up treatment after the study showed steady

improvement; however, data on maintenance and generalization of speaking behaviors as part of this pilot study are not available for report. Future work might examine this protocol in conjunction with comprehensive treatment for SM to assess these changes.

In summary, rewarding successive approximations of speech using this shaping hierarchy is likely to lead to early speech production for children with SM, regardless of the modality in which it is delivered. Importantly, elicitation of speech within the first two sessions of treatment is quite realistic, as all 15 participants in this study accomplished this goal. Likewise, generalization of speech to multiple unfamiliar adults during the second session is an attainable goal, as demonstrated by 14 (93.33%) of these children. Children's experience of anxiety may be lessened by using therapeutic activities such as mobile apps and other fun games, as evidenced by patterns of anxious distress described in this report. It is evident that mobile apps provide some utility during the treatment of SM, and it is possible that mobile devices will demonstrate incremental utility as efforts are made to increase the reach and accessibility of evidence-based procedures for encouraging speech in these children. This would not necessarily be limited to providers, as protocols such as the one described in this investigation might be used by caregivers and teachers, following adequate training, to promote generalization of speaking behaviors to the child's natural environment. Future research efforts in the area of technology and the treatment of SM might focus on this innovative approach, as reach and access would be significantly increased. In truth, the utility and potential of today's technological advances to increase the quality of mental health care is only beginning to be understood, and future research in this area is likely to lead to surprising advances in this effort.

Conflict of Interest Statement

The authors declare that there are no conflicts of interest.

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