

Tolerance of face coverings for children with autism spectrum disorder

Mary Halbur

University of Nebraska Medical Center's Munroe-Meyer Institute

Tiffany Kodak and Marisa McKee

Marquette University

Regina Carroll and Elizabeth Preas

University of Nebraska Medical Center's Munroe-Meyer Institute

Jessi Reidy and Maria Clara Cordeiro

Marquette University

Healthcare professionals and government officials have advised the use of personal protective equipment, such as face masks and face shields, to assist with limiting the spread of the SARS-CoV-2 (COVID-19). Due to the prevalence of challenging behavior associated with other medical routines, the present study evaluated a treatment package composed of graduated exposure, prompts, reinforcement, and escape extinction on tolerance of wearing a face covering for up to 5 min for 12 children with ASD in a systematic replication of Cox et al. (2017) and Sivaraman et al. (2020). We also extended previous research by measuring generalization of face covering type (i.e., face shield) and the efficacy of a treatment extension for tolerating a face covering for up to 15 min during the participants' trial-based instruction and play periods.

Key words: autism spectrum disorder, compliance, face mask, face shield, graduated exposure, tolerance of medical routines

To limit the spread of SARS-CoV-2 (COVID-19), medical professionals recommend children and adults engage in social distancing, frequent hand washing, and wear face coverings (Center for Disease Control [CDC], 2020b). Face coverings are considered a type of personal protective equipment that help prevent the spread of respiratory infections, because COVID-19 is spread from person-to-person by respiratory droplets that

are projected when a person talks, coughs, or sneezes (Liang et al., 2020). Further, the CDC director Robert R. Redfield stated that face masks are “powerful weapons we have to slow and stop the spread of the virus” (CDC, 2020b), and an editorial in the *Journal of the American Medical Association* suggested benefits of universal masking to help reduce transmission of infection (Brooks et al., 2020).

One barrier to limiting the spread of COVID-19 is getting children with autism spectrum disorder (ASD) or other developmental disabilities to tolerate wearing a face covering. Individuals with intellectual and developmental disabilities have a higher prevalence of specific phobia than the general population (Dekker & Koot, 2003), and 33%-50% or more of children with ASD have higher rates of medical fears compared to other children (Evans et al., 2005; Gillis et al.,

We thank Madison Klute, Jennifer Luebbe, Alexander Elston, Angelique Howeth, Claire Philson, Megan Harper, Erik O'Reilly, Kirsten Lloyd, Alyssa Spottek, Landon Cowan, Abigail Stoppeworth, Lauren Debertin, Alexandra Hristakos, and Karly Zelinski for their implementation of the procedures and contributions to data collection. We also thank the medical professionals who completed the pre-study survey.

Address correspondence to: Tiffany Kodak, 525 N. 6th St., Milwaukee, WI 53211; Email: tiffany.kodak@marquette.edu

doi: 10.1002/jaba.833

2009). Additionally, some children with ASD may engage in behavior to avoid medical protective equipment such as face coverings so that they are unable to be safely or appropriately placed on their face (Sivaraman et al., 2020). Children may also remove the face covering frequently or engage in accompanying problem behavior or incompatible behavior (e.g., object mouthing) related to wearing a face covering. If a child cannot or will not wear a face covering, they will be at greater risk for illness when participating in in-person activities such as school, therapy, and community outings (Cheng et al., 2020; Lyu & Wehby, 2020). Furthermore, they may be excluded from full participation in school and in other community settings.

Behavioral interventions can increase compliance with important health care routines and medical devices (e.g., Kupzyk & Allen, 2019; Shabani & Fisher, 2006). For example, Cox et al. (2017) taught children with ASD to tolerate magnetic resonance imaging and reduced motion during imaging. A treatment package consisting of graduated exposure, prompting, and reinforcement increased participants' approach to and duration of time in a mock scanner within the closed coil/scanner bed. During treatment, the experimenter used least-to-most prompting to occasion correct responses and provided a highly preferred edible and praise once the participant engaged in the target step and also at the end of a 30-s interval. If elopement or attempts to leave the scanner occurred during intervention, the instruction was repeated and the target duration for the trial was reset. The treatment package was successful for all participants.

Sivaraman et al. (2020) extended the research on tolerance of medical devices to reduce the risk of viral transmission of COVID-19. They taught six children with ASD to wear face masks via a telehealth treatment package. In baseline, the experimenter prompted the participant to put on the mask and terminated sessions following problem behavior or noncompliance. Prior to each treatment session, brief preference assessments

were conducted to identify preferred items to provide as reinforcers contingent on successful completion of a step. Treatment sessions consisted of presenting smartphone images and telehealth demonstrations of mask wearing, explaining the purpose of mask wearing, and then having the caregiver begin a 15-step graduated exposure hierarchy. During treatment, caregivers received coaching and prompts from the experimenter via telehealth to correctly implement graduated exposure. Following two successful sessions at a target step, subsequent steps were added. Participants were permitted to advance through the exposure hierarchy prior to meeting the move-on criterion if they tolerated a subsequent step without requiring prompts. If the participant did not tolerate all but one of the targeted steps in the exposure hierarchy for two consecutive sessions, the complete hierarchy was retrained from the start. Results of Sivaraman et al. demonstrated the efficacy of a graduated exposure and reinforcement treatment package on mask-wearing behavior for 10 min for six children with ASD. Generalization was observed across masks types and settings. However, additional research is needed with more participants (including younger participants), varied facial coverings (e.g., face shields), and additional contexts (e.g., therapy setting).

The purpose of the present investigation was to partially replicate a behavioral treatment package composed of graduated exposure, prompts, and differential reinforcement from Cox et al. (2017) and extend this treatment package to teach children with ASD to tolerate face coverings. Furthermore, the current study replicates some methods of Sivaraman et al. (2020) with the addition of escape extinction during treatment, and extends this treatment package to another type of facial covering, more participants, and different formats of intervention delivery (e.g., in person, via telehealth with two parents, via telehealth with the client placing on their own mask).

Method

Participants and Settings

Twelve children with ASD participated or partially participated in the investigation. Participants were recruited from two comprehensive behavioral treatment clinics in the Midwest (six from each clinic). See Table 1 for demographic information (i.e., age, gender, ethnicity, diagnosis, VB-MAPP level, and history of tolerance training) for each participant as well as the face covering(s) targeted.

For nine participants, sessions took place in the participant's typical area of the clinic used for comprehensive behavioral treatment. For two participants (Harrison, Pete), all sessions were conducted via telehealth. Telehealth sessions occurred in a quiet room with minimal distractions, and the participant's therapist(s) were present via Zoom. For one participant (Elias), sessions took place in clinic and via

telehealth. For all sessions, the rooms contained a table and chairs. For Pete and Elias, a therapist coached the parent to conduct sessions via telehealth. For Harrison, a therapist coached him to conduct the procedures independently via telehealth.

Materials

Session materials consisted of face masks or face shields and data collection materials (i.e., timers, clipboards, data sheets, pens, video camera). Child-sized face masks and shields were provided by the participant's parents and the clinics. Two to five face masks were included in eight of participants' treatment sessions to promote generalization to a variety of face masks (e.g., cloth mask with and without a nose clip, surgical mask, cloth masks with different ear-hoop adjusters). Face masks and shields were cleaned and sanitized according to clinic

Table 1

Participant Information

P	Age	Gender	Ethnicity	Diagnosis	VB-MAPP Level	Previous Tolerance Training(s)	Face Covering(s) Targeted
Carl	5	M	Caucasian	ASD	Level 3	haircutting, toileting	Mask (FS probed)
Elias	4	M	Caucasian	ASD	Level 1/2	toilet training*	Mask (FS probed)
Harrison	10	M	Caucasian	ASD, ADHD (combined presentation)	N/A	nail trimming, haircutting	Mask
Pete	9	M	Caucasian	ASD	Level 3	haircutting, dressing	Both
Wendell	4	M	Caucasian	ASD	Level 1	N/A	Mask (FS probed)
Kevin	4	M	Caucasian	ASD	Level 1	toileting, wearing shoes	Mask (Discontinued)
Allen	7	M	Caucasian	ASD	Level 3	variation in game play, using bathroom	Both
Nolan	9	M	Caucasian	ASD	N/A	nail clipping, wet wipe use following bowel movements	Both
Javier	4	M	Hispanic	ASD	Level 2	N/A	Mask (FS in TX EXT)
Ryan	6	M	Caucasian	ASD	Level 1	toileting, tooth brushing*, iPad removal*	Mask (Discontinued)
Malik	7	M	South Asian	ASD	Level 3	haircutting	FS (Mask probed)
George	9	M	Caucasian	ASD, moderate intellectual disability	Level 3	haircutting, lotion application	FS (Discontinued)

Note. P = participant pseudonym, * = ongoing tolerance programs, FS = face shield, TX EXT = treatment extension.

policies. Sessions were video recorded for data collection purposes. Preferred leisure items (e.g., iPad or Kindle) were identified for each participant to use as noncontingent reinforcement during treatment sessions. Additionally, two to five edibles were identified for each participant based on therapist and caregiver report and daily brief MSWOs (Carr et al., 2000). Highly preferred edibles were selected as reinforcers for tolerance during intervention due to evidence these items functioned as reinforcers in the participant's previous clinical programs and in the treatment procedures on which study methods were based (Cox et al., 2017).

Response Measurement

See Table 2 for the exposure hierarchies of face mask and face shield steps. During each session, observers recorded the number of steps

tolerated. *Tolerating the step(s)* was defined as allowing the adult (i.e., therapist or parent) to complete the step without engaging in blocking or problem behavior. *Not tolerating the step(s)* was defined as engaging in blocking or problem behavior. *Blocking* was defined as contact between any part of the participant's body and the adult's hand or the face covering by engaging in behavior which stopped the adult from completing the task and the materials from being placed near or touching the participant's body at the location specified by the current step before the step duration was complete. Head turns did not count as blocking, and the therapist continued with the target step. For Harrison, *blocking* was defined as contact between his body and his face covering which stopped the covering from touching his body at the location specified by the current step before the full duration passed. *Problem behavior* consisted of any actual or attempted aggression, disruption, elopement, and flopping. However, problem behavior rarely occurred across participants or directly coincided with blocking behavior. (Contact the first author for operational definitions of problem behavior.)

Duration of baseline and treatment sessions was recorded during all sessions with a stopwatch. The duration timer started when the discriminative stimulus (e.g., "Let's put on your mask") was stated in baseline and the treatment extension sessions, or after the therapist handed the client an electronic device during treatment. The duration timer was stopped in baseline after the 30-s reinforcement interval provided after the mastered tasks. The duration timer was stopped in treatment after the 20-s reinforcement interval.

Table 2

Face Covering Exposure Hierarchies

	Face Mask	Face Shield
#	Step	Step
1	Pick up mask	Pick up face shield
2	Bring within 3 feet of participant's body	Bring within 3 feet of participant's body
3	Bring within 12 in of face	Bring within 12 in of face
4	Bring within 1 in of face	Bring within 1 in of face
5	Touch against face and over nose	Touch against forehead (angled up) with strap extended out/up
6	Hooked to 1 ear	Pull strap around back of head
7	Hooked to 2nd ear (both ears now secure)	Secure and straighten (tighten, if applicable)
8	Over face and straighten (nose spot or ear straps should be tightened, if applicable)	Tolerate face shield for 1 s
9	Tolerate mask for 1 s	Tolerate face shield 5 s
10	Tolerate mask 5 s	Tolerate face shield for 10 s
11	Tolerate mask for 10 s	Tolerate face shield 30 s
12	Tolerate mask 30 s	Tolerate face shield for 1 min 15 s
13	Tolerate mask for 1 min 15 s	Tolerate face shield for 3 min
14	Tolerate mask for 3 min	Tolerate face shield for 5 min
15	Tolerate mask for 5 min	

Reliability and Treatment Integrity

A second trained observer independently collected data in real time or from video recordings for a minimum of 33% of the sessions for each participant. Interval IOA data were

collected in which each step in the exposure hierarchy was counted as one interval. An agreement was defined as two observers recording the same behavior (i.e., tolerated or not tolerated) for each step in a session. The number of steps with an agreement was divided by the number of steps in the session and multiplied by 100. Data from all IOA sessions were averaged to calculate means for each participant. Treatment extension IOA was scored the same way, except the frequency of blocking was also included. For duration, IOA was measured by two trained observers for a minimum of 33% of sessions. For each session, the smaller duration was divided by the larger duration and multiplied by 100. Sessions were averaged to calculate means for each participant. See Table 3 for IOA scores for each participant.

A trained observer also collected data on the therapist's implementation of the procedure according to the protocol. For each step of the exposure hierarchy, an independent observer recorded a plus if all components were implemented according to the protocol, recorded a minus if there were one or more error(s), and recorded an N/A if there was no opportunity to implement a step. Additionally, integrity data were collected on the other components of baseline and treatment as listed in Table 4 for six participants (Carl, Elias, Wendell, Kevin, Javier, Ryan). The number of components (including exposure hierarchy steps and other components) implemented correctly was divided by the total number of components, multiplied by 100. Treatment integrity data were collected for a minimum of 33% of sessions and averaged to calculate means for each participant. See the right columns in Table 3 for treatment integrity scores for participants.

Experimental Design

The 12 participants were assigned to dyads consisting of two participants. Five dyads were arranged according to a multiple-probe design

across participants. One dyad was arranged according to a nonconcurrent multiple-baseline design across participants. One participant (George) dropped out of the evaluation so that high rates of problem behavior occurring across a variety of his clinical programs could be assessed and treated. Two participants (Kevin and Ryan) were discontinued after partial treatment progress due to competing behavior (i.e., Ryan licked his face mask excessively) or medication changes and variable rates of problem behavior occurring outside the present investigation (Kevin). Modifications to the treatment package for these three participations continued during their appointments but are not reported here. However, data for George, Ryan, and Kevin are included in the figures to show stability in behavior while other participants received treatment, as well as to show partial treatment effects.

For one participant (Harrison), data were collected on tolerance of the face mask only (based on parent request). For 10 participants, data on tolerance of the face mask and face shield were collected. In addition, generalization data for the face shield were collected prior to, during (Carl, Elias, Wendell, Kevin, Javier, and Ryan), and following treatment for the face mask (Carl, Elias, Wendell, Javier, Allen, Nolan, and Pete). For one participant (Malik), generalization data for the face mask were collected prior to and following treatment for the face shield. Mastery of a step was defined as two consecutive sessions with the target step and all previous steps tolerated. Mastery of the entire exposure hierarchy was defined as two consecutive sessions with all steps in the exposure hierarchy tolerated.

Pre-Study Survey

Prior to the start of the present investigation, a brief medical consultation survey was sent to select healthcare providers to gather information on the use of face coverings for children with ASD who receive behavioral intervention.

Table 3*Participant Interobserver Agreement and Treatment Integrity*

P	Interobserver Agreement			Duration		Treatment Integrity		
	% w/IOA	IOA	Range	IOA	Range	% w/TI	TI	Range
Carl	62	98	87-100	98	87-100	62	99	92-100
Elias	58	99	67-100	97	91-100	58	99	94-100
Harrison	56	99	91-100	92	66-100	57	99	91-100
Pete	44	99	93-100	96	74-100	44	98	90-100
Wendell	57	98	83-100	97	94-100	57	99	85-100
Kevin	48	97	83-100	98	93-100	48	99	91-100
Allen	46	100	-	99	97-99	96	96	86-100
Nolan	46	97	87-100	94	71-100	46	96	80-100
Javier	58	99	83-100	99	95-100	58	99	95-100
Ryan	36	98	80-100	98	94-100	36	99	89-100
Malik	36	97	89-100	95	67-100	36	95	86-100
George	50	94	78-100	99	94-100	50	99	89-100

Note. P = participant, IOA = interobserver agreement, TI = treatment integrity.

The survey asked medical professionals to describe benefits and limitations to children wearing face coverings. Medical professionals were also asked whether they recommended a specific type of face covering for children with ASD based on self-stimulatory behavior (e.g., finger mouthing), use of an oral-motor tool such as a chewy, frequent face touching, and wearing glasses. See Supporting Information for a copy of the survey. Five health care providers (i.e., two pediatricians, two medical students, and one pediatric nurse practitioner) recommended teaching children with ASD to tolerate wearing face coverings (i.e., face masks and/or face shields). The results of the survey confirmed the social validity of (a) having children with ASD tolerate and wear face coverings, (b) use of more than one type of face covering (i.e., face mask and face shield), when possible and relevant, and (c) reducing behavior that might disrupt the face covering. The medical consultation was used to guide the selection of face coverings, along with caregiver preference and community, federal, and school guidelines.

Procedure

A therapist (10 participants), parent (for all of Pete's sessions, and a portion of Elias's

sessions), or the participant himself (Harrison) implemented the session procedures. A modified set of procedures were used for the participant who implemented treatment himself; see Table 5. Hereafter, "therapist" will be used to describe either the clinic therapist or parent, both of whom were trained to implement the procedures. Sessions were conducted once or three times per day, 2 to 5 days per week. A minimum of 10 min occurred between each session.

Baseline

The therapist stood or sat next to the participant (depending on their typical arrangement) and began the trial by stating, "Let's put on your (mask or face shield)." Following the instruction, the therapist initiated the first step of the exposure hierarchy and moved through each step of the exposure hierarchy in approximately 2-5 s. No consequences were provided contingent on tolerance of any steps. The session terminated following a step that was not tolerated or completion of the entire exposure hierarchy. Following termination of the session, two mastered tasks were presented. Least-to-most prompting (i.e., vocal, model, physical) was used to occasion a correct response to the

Table 4*Treatment Integrity Definitions*

TI Component	Definition
Correct SD	Therapist says the correct SD in a clear voice prior to starting the first exposure hierarchy step.
Begins/ends at correct step	Therapist begins each session at the first step and then stops at the correct target step based on the phase (as listed in the exposure hierarchy/protocol).
Responds to problem behavior	Therapist implements a momentary DRO requirement for problem behavior at the final target step and responds to problem behavior correctly during the procedure.
Provides correct consequence/reinforcer	Therapist provides preferred electronics (noncontingently) during treatment and for 20 s following treatment completion and provides an edible following the absence of problem behavior/blocking in the target step.
Mastered tasks in baseline	Therapist provides two mastered tasks at the end of each baseline session and uses least-to-most prompting to occasion correct responses, as needed.
Brief preference assessment	Therapist provides an array of 2-4 items, allows a choice, gives the participant the selected item, and gets the selected item ready for the end of the session.
Pre-session iPad [®] access	Therapist provides the iPad [®] prior to the start of the treatment session for 15 s (+/- 5 s, or until an advertisement was over/video loaded).

Note. TI = treatment integrity, SD = discriminative stimulus, DRO = differential reinforcement of other behavior.

mastered tasks. Following a correct response to the second mastered task, the therapist provided access to a preferred tangible item, based on case manager nomination, for 30 s.

Baseline data were used to identify the number of exposure hierarchy steps to target at the onset of treatment. Treatment typically began one step above the baseline session average. For example, if the participant tolerated seven steps of the exposure hierarchy during baseline, treatment began by targeting tolerance of eight steps of the exposure hierarchy. During or following

treatment for one face covering, baseline sessions were conducted to evaluate generalization to the other face covering.

Treatment Package (Graduated Exposure, Prompts, Escape Extinction, and Differential Reinforcement)

Prior to each session, the therapist presented an array of two to four edible items to the participant and offered a selection. Following a selection, the participant consumed the item, and the therapist provided a statement about working for the selected item (e.g., “okay, we will work for more [item]”). Participants with more advanced mand repertoires vocally mandated for the item to work for during each session.

Following the one-trial preference assessment or vocal mand, the therapist provided access to a preferred electronic item based on caregiver or case manager nomination (iPad) for approximately 15 s. While the participant continued to have noncontingent access the electronic item, the therapist said, “Let’s put on your (mask or face shield) and immediately initiated the steps of the exposure hierarchy. If the participant did not tolerate a step (i.e., tried to block the therapist hands, removed the mask, or engaged in problem behavior), the therapist continued with the step as outlined in the exposure hierarchy and used the least amount of physical guidance necessary to guide the participant’s hands onto his lap or the table. If the participant removed the face covering during treatment, the therapist put the face covering back on the participant at an accelerated speed (fewer than 2 to 5 s occurred between steps of the exposure hierarchy).

If problem behavior or blocking occurred, the therapist continued through the exposure hierarchy to the target step until there was at least a 1-s pause in blocking/problem behavior (i.e., the therapist implemented a momentary differential reinforcement of other behavior procedure to reduce the likelihood of these

Table 5*Minor Participant Modifications*

P	Modification	Rationale
Carl	Removed step 6 from the face shield exposure hierarchy.	His face shield did not have a strap.
Carl	Added hands-down rule and physical prompt following face touches during sessions that were 5-min or longer.	Started to touch and pull down mask while talking to therapist (i.e., exposing his mouth to speak while the ear straps were still secured); participant received the edible if he did not remove his mask.
Elias	Switched to telehealth for a few sessions at step 13.	Due to a quarantine.
Harrison	Client implemented procedures via telehealth with therapist vocal prompts instead of escape extinction. Vocal and gesture prompts were repeated for target steps until criteria was met or if blocking occurred. The therapist continued delivering the vocal demand and gesture prompt every 5 s until he completed the step (or until a cap of 5 min).	Services conducted solely via telehealth without parent participation.
Wendell	Modified the definition of tolerance to allow up to one instance of blocking per session.	Due to tolerance of placing the face mask back on his face following blocking.
Ryan	Went back 3 steps.	Mask fit poorly and fell off during longer sessions; switched to a mask with a nose clip; repeated previous 3 steps of the exposure hierarchy due to blocking application of new mask type.

Note. P = participant.

behaviors in the future). If blocking or problem behavior did not occur at the target step, the therapist provided an edible and enthusiastic,

descriptive vocal praise (e.g., “Great job wearing your mask/face shield”) upon completion of the step. If blocking or problem behavior occurred during the target step, the therapist provided praise only (no edible item). The therapist then removed the face covering by touching the ear straps of the mask or strap of the face shield, and the participant continued to have access to the electronic item for 20 s after removal of the face covering.

Treatment continued at the targeted exposure hierarchy step until the step mastery criterion was met. The treatment package continued to be implemented for all remaining steps of the exposure hierarchy until the overall exposure hierarchy mastery criterion was met (i.e., two consecutive sessions with tolerance of all steps). During and/or following the completion of treatment for one face covering, baseline sessions for the other face covering occurred to assess generalization. Some participants (i.e., Allen, Pete during treatment, and Javier in the treatment extension) who did not display overall mastery of the exposure hierarchy during generalization sessions were exposed to treatment for the second face covering. Implementation of treatment for the second face covering for those participants was based on parent request.

Procedural Modifications

Minor procedural modifications were made for specific participants based on the type of face covering they used, or observed behavioral patterns. See Table 5 for a summary of these modifications with brief rationales.

Treatment Extension

Once baseline generalization or treatment sessions of the second face covering were completed, treatment extension sessions were conducted to evaluate whether participants would continue to wear their masks during trial-based instruction and/or natural environment training (NET). The therapist identified some trial-based skill-acquisition programs to conduct during sessions, avoiding

programs that had historically evoked high rates of problem behavior. These programs varied based on individual client goals.

Prior to the start of each treatment extension session, the therapist conducted two brief preference assessments (one for edible and one for tangible items). The edible preference assessment was identical to the one conducted in the treatment package (described above), and the selected edible item was provided at the end of a 5-min interval contingent on the absence of blocking and problem behavior. The tangible preference assessment consisted of providing an array of 2 to 4 tangible items to the participant and allowing up to 10 s for a choice. The toy or electronic item selected was provided in reinforcement intervals during trial-based instruction. Mands for access to alternative items were also honored, and participants with a mand repertoire were permitted to mand for the tangible item included during instructional trials instead of completing the preference assessment.

5-min Treatment Extension (Trial-Based Instruction; Treatment Extension 1). The session arrangement was identical to the treatment package, except the therapist removed noncontingent access to the preferred electronic item and began conducting trial-based instructional programs, once the participant's face covering was secured to his face, for some participants (i.e., Carl, Elias, Wendell, Javier, and Pete). For Malik, Allen, Nolan, and Harrison, noncontingent access to the preferred electronic item was not provided while the face covering was being applied during these sessions. Trial-based instruction included client-specific reinforcers (i.e., praise, tangible items, tokens) for correct responding and prompt-fading procedures, based on their individualized intervention procedures.

If the participant did not tolerate a step during the 5-min session, the therapist used the same procedure to guide down hands and replace the face covering as described in the treatment package. After 5 min, the face

covering was removed by touching the ear straps of the mask or the strap of the face shield. If blocking or problem behavior occurred during the 5-min session, the therapist provided praise only at the end of the 5 min (no edible item). If blocking or problem behavior did not occur, the therapist provided an edible and enthusiastic, descriptive vocal praise (e.g., "Great job wearing your mask/face shield").

15-min Treatment Extension (Treatment Extension 2). These sessions included the same session arrangement, prompts, and reinforcers as in the 5-min treatment extension sessions with two exceptions. First, either (a) an edible was placed in a cup for each 5-min period in which the participant did not engage in blocking or problem behavior (Malik, Allen, Nolan, and Pete) or (b) three edibles were provided at the end of the 15-min session (i.e., one edible for each successful 5-min period; Carl and Wendell). At the end of the 15-min session, the therapist removed the participant's face covering and allowed the participant to consume the accumulated edibles. Second, younger participants (Carl and Wendell) had 15-min sessions composed of trial-based instruction and NET. For half of the 15-min session, participants engaged in NET activities in their designated play area. Older participants (Malik, Allen, Nolan, Harrison, and Pete) completed trial-based instruction programs for 15 min.

Results

Figures 1-3 show results for each participant. Carl's results are in the top panel of Figure 1. During baseline, Carl tolerated eight to nine steps of the exposure hierarchy for the face mask and seven to nine steps of the exposure hierarchy for the face shield. He progressed through each step of the exposure hierarchy in two to seven treatment sessions. Carl also engaged in low levels of blocking during the treatment extension at both 5 min and 15 min.

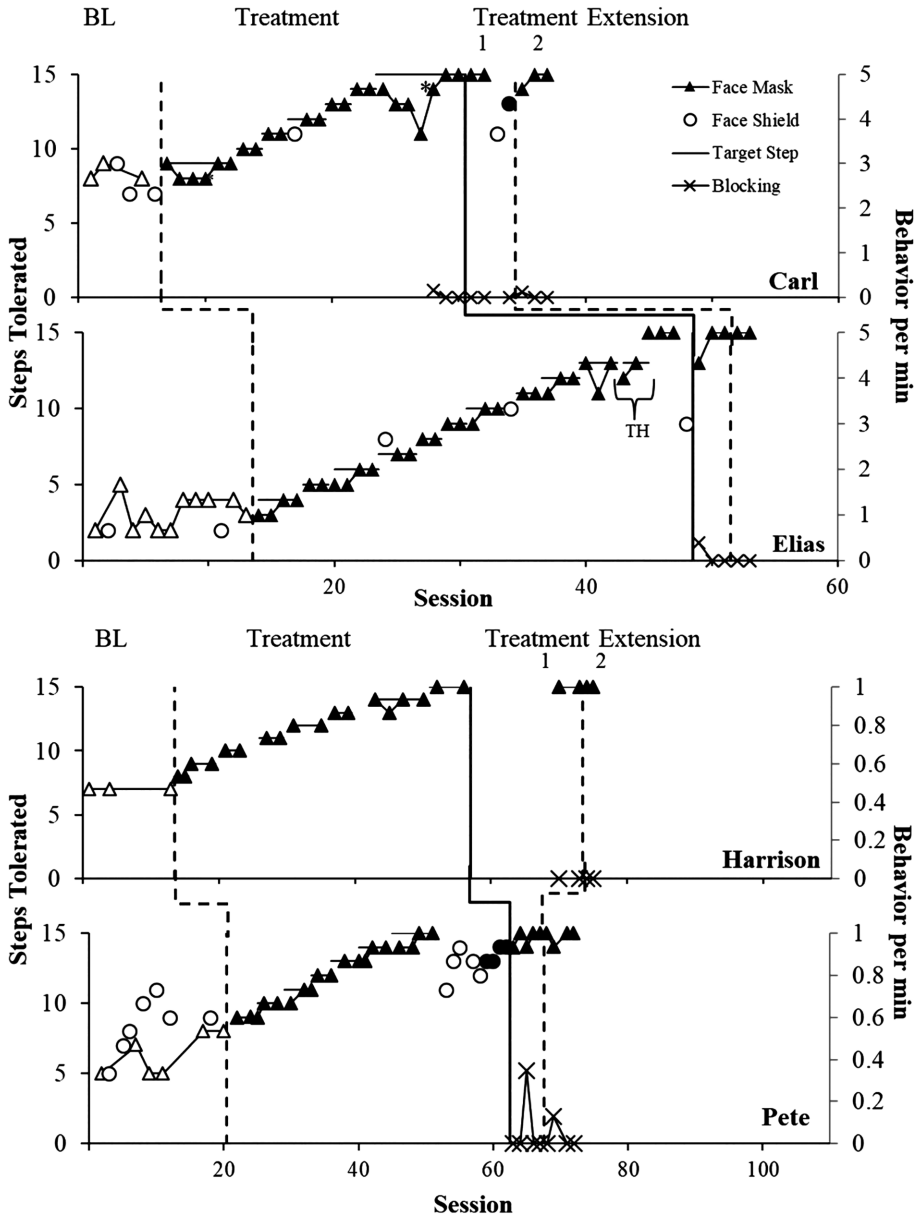
During generalization probes with the face shield, Carl tolerated more steps than in baseline; however, we implemented one treatment extension session with Carl's face shield to show the treatment would further increase his tolerance. Elias's results are shown in the second panel of Figure 1. During baseline, Elias tolerated two to five steps of the exposure hierarchy for the face mask and two steps of the exposure hierarchy for the face shield. During treatment, Elias mastered each step of the exposure hierarchy (from step 4 to 12) in four or fewer treatment sessions. At step 13, Elias's treatment changed to telehealth due to a quarantine. During this quarantine, sessions were conducted via telehealth with his mom. After he tolerated his mask at step 13 for one session, the importance of mask wearing during his quarantine led us to conduct a session at the terminal step of the exposure hierarchy. During this session, he successfully wore the face mask for 5 min with his mom. Following his return to the clinic, he also met mastery for the final step of the exposure hierarchy. Generalization probes showed Elias's tolerance of the face mask only moderately generalized to the face shield. Elias also engaged in low levels of blocking during the treatment extension at both 5 min and 15 min. Harrison's results are shown in the third panel of Figure 1. During baseline, Harrison tolerated two to four steps of the exposure hierarchy for the face mask. He progressed through each step of the exposure hierarchy in two to four treatment sessions. Harrison engaged in low levels of blocking during the treatment extension at both 5 min and 15 min. Pete's results are shown in the third panel of Figure 1. During baseline, Pete tolerated five to eight steps of the exposure hierarchy for the face mask and seven to 11 steps of the exposure hierarchy for the face shield. During treatment, Pete mastered each step of the exposure hierarchy in two to four treatment sessions. During generalization probes, we observed a slight increase in steps tolerated for

the face shield but responding was not at mastery level. Thus, treatment was introduced for the face shield, and Pete displayed rapid tolerance of the remaining steps. Pete engaged in low but variable levels of blocking during the 5-min and 15-min treatment extension.

Wendell's results are in the top panel of Figure 2. During baseline, Wendell tolerated nine to 12 steps of the exposure hierarchy for the face mask and eight steps of the exposure hierarchy for the face shield. He progressed through each step of the exposure hierarchy in two to 16 treatment sessions. Wendell engaged in variable and low levels of blocking during the treatment extension at 5 min and 15 min, respectively. Generalization probes showed Wendell's tolerance of the face mask did not generalize to the face shield. Kevin's partial results are shown in the second panel of Figure 2. During baseline, Kevin tolerated three to seven steps of the exposure hierarchy for the face mask and five steps of the exposure hierarchy for the face shield. During his time in treatment, Kevin mastered six steps on the exposure hierarchy in five or fewer treatment sessions. Kevin discontinued participation in the investigation due to medication irregularities as well as increased rates of problem behavior throughout his clinical service delivery. Allen's results are shown in the third panel of Figure 2. During baseline, Allen tolerated 10 to 15 steps of the exposure hierarchy for the face mask and 13 to 14 steps of the exposure hierarchy for the face shield. He progressed through each step of the exposure hierarchy in two to three treatment sessions. During generalization probes with the face shield, Allen tolerated the same steps as in baseline; thus, a brief treatment was also introduced for the face shield. His responding met mastery for the face shield in two treatment sessions. Allen engaged in low levels of blocking during the treatment extension at both 5 min and 15 min. Nolan's results are shown in the fourth panel of Figure 2. During baseline, Nolan tolerated three to 13 steps of the exposure hierarchy for the face mask and 8 to

Figure 1

Results for Carl, Elias, Harrison, and Pete

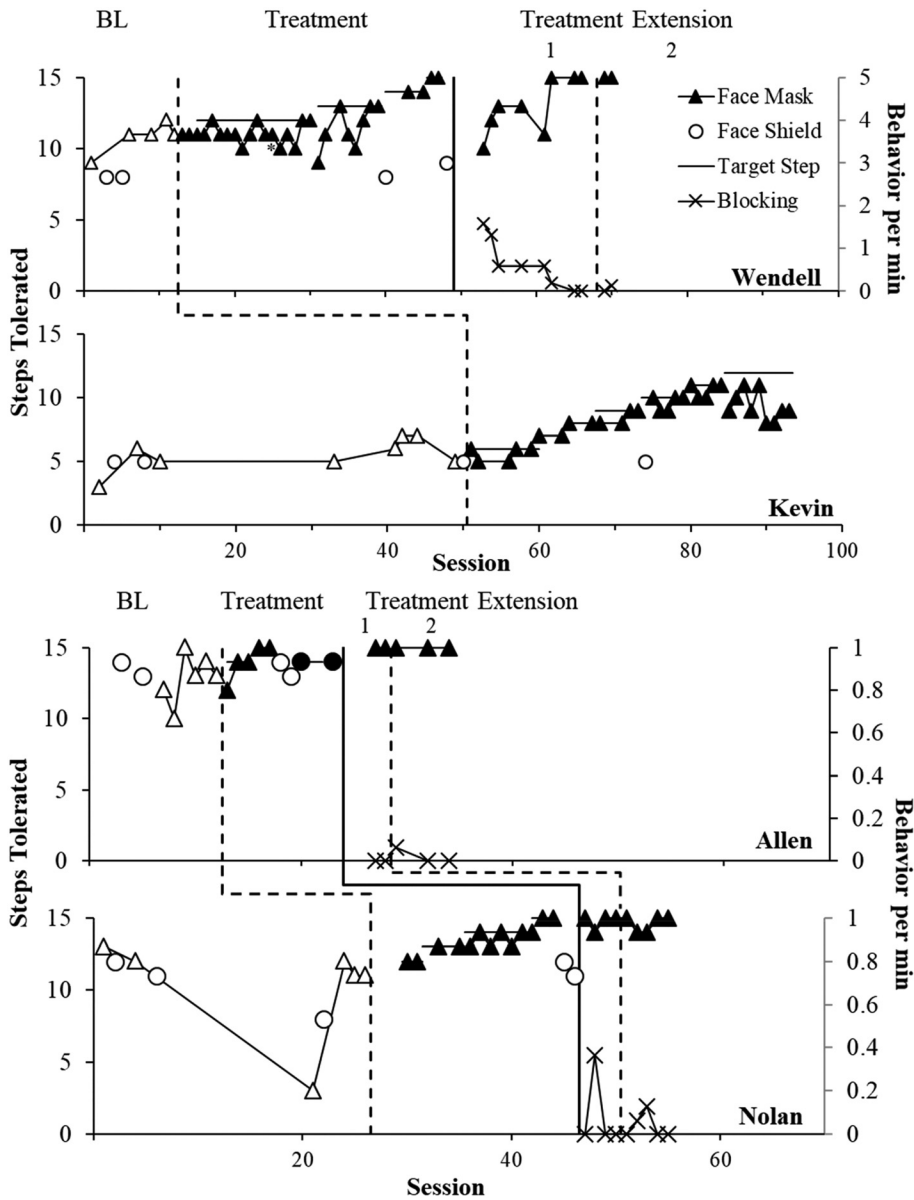


Note. BL = baseline, Treatment extension 1 = 5-min sessions, Treatment extension 2 = 15-min sessions, * = treatment modifications; see table. TH = Telehealth sessions.

12 steps of the exposure hierarchy for the face shield. During treatment, Nolan mastered each step of the exposure hierarchy in two to seven treatment sessions. Generalization probes showed

Nolan’s tolerance of the face mask did not generalize to the face shield. Nolan also engaged in low levels of blocking during the treatment extension at both 5 min and 15 min.

Figure 2
Results for Wendell, Kevin, Allen, and Nolan

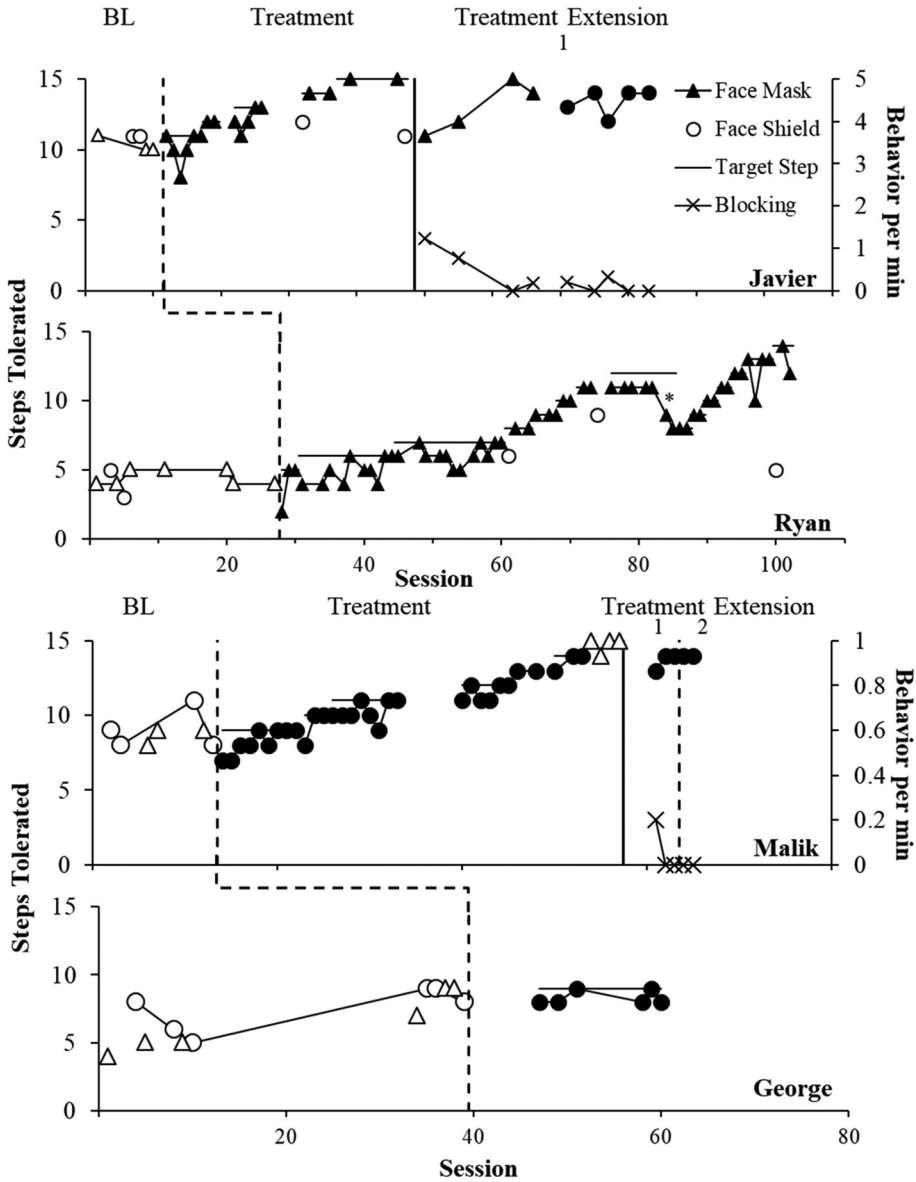


Note. BL = baseline, Treatment extension 1 = 5-min sessions, Treatment extension 2 = 15-min sessions, * = treatment modifications; see table.

Javier's results are shown in the top panel of Figure 3. During baseline, Javier tolerated 10 to 11 steps of the exposure hierarchy for the face mask and 11 steps of the exposure hierarchy for the face shield. He progressed through

each step of the exposure hierarchy in two to seven treatment sessions. Javier engaged in low levels of blocking during the treatment extension at 5 min; however, he engaged in high levels of licking his face mask. Due to safety

Figure 3
Results for Javier, Ryan, Malik, and George



Note. BL = baseline, Treatment extension 1 = 5-min sessions, Treatment extension 2 = 15-min sessions, * = treatment modifications; see table.

concerns regarding mask licking and collaboration with his family, we modified the treatment extension sessions to include the face shield rather than the mask. Javier engaged in low levels of blocking with the face shield during

the treatment extension sessions. Ryan’s partial results are shown in the second panel of Figure 3. During baseline, Ryan tolerated four to five steps of the exposure hierarchy for the face mask and three to five steps of the exposure

hierarchy for the face shield. During treatment, Ryan mastered nine steps on the exposure hierarchy until his mask type changed to include a nose clip; this modification required treatment to move back a few steps. Similar to Javier, Ryan engaged in high rates of mask licking when exposed to longer steps of the exposure hierarchy (e.g., 5 min for step 14); therefore, his participation in the study with that face covering was discontinued. Malik's results are shown in the third panel of Figure 3. During baseline, Malik tolerated eight to nine steps of the exposure hierarchy for the face mask and eight to 11 steps of the exposure hierarchy for the face shield. He progressed through each step of the exposure hierarchy in two to eight treatment sessions. Malik's responding generalized to the face mask meeting mastery in four sessions. Malik engaged in low levels of blocking during the 5- and 15-min treatment extension sessions. George's partial results are shown in the fourth panel of Figure 3. During baseline, George tolerated four to nine steps of the exposure hierarchy for the face mask and five to nine steps of the exposure hierarchy for the face shield. During treatment, George did not meet mastery for any steps prior to discontinuing his treatment to assess and treat severe problem behavior that occurred across his clinical programs.

Table 6 displays results for durations across participants. The durations displayed in the middle column are for the treatment only for each participant, and the durations in the right column are for total participation in the study (i.e., baseline, generalization, and treatment extension). Treatment duration ranged from 25.6 min to 66.8 min across participants. Total duration ranged from 89.7 min to 155 min.

Discussion

The results of the present investigation systematically replicated and extended Cox et al. (2017) and Sivaraman et al. (2020) on

Table 6

Duration Results Across Participants

P	Treatment Duration	Total Duration
Carl	66.8	138
Elias	53.6	114.8
Harrison	41.9	89.7
Pete	48.7	196.9
Wendell	64.9	151.3
Kevin	N/A	N/A
Allen	25.6	148.9
Nolan	43.9	155
Javier	45.9	106.8
Ryan	N/A	N/A
Malik	57.87	133.98
George	N/A	N/A

Note. Durations are listed in minutes. Treatment duration = duration of first (or only) face covering trained. Total duration also includes baseline, generalization, and treatment extension sessions. N/A = participation discontinued prior to mastery.

reinforcement-based approaches to increase tolerance with medical devices. Similar to previous research, our results indicated that a treatment package composed of graduated exposure, prompts, and differential reinforcement produced tolerance of the application and extended use of face coverings for nine children with ASD. We were also able to increase tolerance of a face covering for two of three participants that were discontinued. Notably, the treatment package was successful, with minor modifications, for children with ASD of multiple ages (range, 4-10 years old), skill levels (VB-MAPP levels 1-3), and histories of tolerance training. The procedure was also accurately conducted and successfully implemented (Pete) or partially implemented (Elias) by a parent of a child with ASD, and by one participant himself (Harrison). Thus, the procedure of the present investigation replicated Sivaraman et al. (2020) with the use of a (a) a multicomponent treatment package consisting of a graduated exposure hierarchy, (b) telehealth participation (for some participants), (c) participant-specific procedural variations, (d) varied masks, and (e) measurement of generalization across contexts.

The present study differed from and extended Sivaraman et al. (2020) in several ways. First, we conducted sessions in-person and via telehealth in the present study, whereas all sessions were conducted via telehealth in Sivaraman et al. (2020). Demonstrating the efficacy of the intervention delivered in multiple formats is beneficial, given variation in treatment delivery modalities during the pandemic. Furthermore, previous researchers (Cox et al., 2017) have suggested that generality and practicality should be emphasized in research on compliance with medical routines.

Second, we extended previous research by targeting tolerance of face shields for many participants, in addition to the kinds of multiple face masks used by Sivaraman et al. (2020). Multiple face covering types were included in the present study due to public health guidelines, recommendations from health care providers, and parental preference. We measured generalization across face coverings for 10 of the 12 participants. The results for one participant showed that tolerance of one face covering generalized to mastery-level tolerance of another face covering, and the results of three participants showed partial generalization (i.e., tolerance for multiple steps increased). Additionally, based on parental preferences and request, two participants received treatment for both types of face coverings. Due to variable levels of generalization across face covering types, additional research is needed to evaluate strategies that increase generalization.

Third, the treatment package included escape extinction for the target step of the exposure hierarchy (and previously acquired steps) for all participants except Harrison. Escape extinction in the present investigation consisted of blocking the removal of the face mask or immediately reapplying it to prevent the removal of the putative aversive stimulus (Iwata et al., 1990). Escape extinction was not included in previous research on mask tolerance (Lillie et al., 2021; Sivaraman et al. 2020). A recent review on

tolerance training (Kupzyk & Allen, 2019) found that approximately 32% of studies include escape extinction. Thus, additional studies could compare the outcomes of tolerance procedures with and without escape extinction. However, it should be noted that a functional analysis was not conducted prior to the present study nor previous studies on tolerance of face coverings, and it remains unknown whether participants' blocking and problem behavior was maintained by escape from the application and use of a face covering. Furthermore, there are some potential limitations with the use of extinction-based procedures (e.g., emotional responding), and there are some conditions under which escape extinction may not be possible for practitioners and parents. For example, escape extinction may evoke high rates problem behavior (e.g., aggression) or it is possible that the use of escape extinction may lead to a higher possibility of COVID-19 transmission due to frequent touching of the participant's facial covering. Future researchers should evaluate the efficacy and efficiency of tolerance training procedures with and without escape extinction.

Fourth, in the present study, tolerance of face coverings was achieved in less time than previous studies (i.e., Lillie et al., 2021; Sivaraman et al., 2020). For example, the mean durations of treatment for participants were 68 min (range, 58 to 76 min) and 540.5 min (range, 216 to 848 min) in Sivaraman et al. (2020) and Lillie et al. (2021), respectively, whereas the mean duration of treatment in the present investigation was 49.9 min (range, 25.6 to 66.8 min). However, Sivaraman et al. had a different mastery criteria duration (i.e., 10 min) than did the present investigation and Lillie et al.

Certain procedural variables may have influenced the duration of intervention across studies. For example, unlike Sivaraman et al. (2020), we did not restart training of the exposure hierarchy based on participant responding at the target step. In addition, the inclusion of escape extinction in the present investigation

may have reduced the overall treatment duration. All but one of the participants in Sivaraman et al. engaged in problem behavior during one or more treatment and generalization sessions. Thus, exposure to escape from the face covering during treatment may have extended the number of treatment sessions needed to reach the terminal criterion in Sivaraman et al. In contrast, participants in the present investigation were not permitted to escape the face covering contingent on blocking and problem behavior and received differential reinforcement based on the absence of blocking or problem behavior at the current step of the exposure hierarchy. Further, most of participants in the present investigation had low levels of problem behavior across treatment and generalization sessions. However, results may differ for clients with higher levels of problem behavior throughout treatment. Researchers and practitioners seeking to implement our treatment package must consider whether the potential benefits of escape extinction (e.g., putative reduction in treatment duration) outweigh the potential limitations (e.g., continued problem behavior when the mask is reapplied, reduced social validity, possibility of increased transmission of illness).

Finally, the present investigation also differed from Sivaraman et al. (2020) because we included one participant (Harrison) who independently completed the steps of the exposure hierarchy via telehealth without the assistance of a caregiver. As such, no physical prompts or escape extinction were included in Harrison's treatment. This differs from Sivaraman et al. (2020) because their intervention was delivered by caregivers. Harrison's results suggest that a graduated exposure and differential reinforcement treatment package may be a viable option to increase independent application and tolerance of face coverings in some children with ASD, although future research is needed on demographics, necessary prerequisite skills (e.g., verbal repertoires, motor skills), and characteristics of

participants that may benefit from this treatment modification.

Similar to Sivaraman et al. (2020), some idiosyncratic modifications were necessary for participants based on observed patterns of behavior, participant-specific repertoires, or face coverings. Making modifications based on observed patterns of behavior and functional relations is common in the behavior-analytic literature (e.g., Bergmann et al., 2020; Hanney et al., 2019; Kisamore et al., 2016; Shillingsburg et al., 2014; Tiger et al., 2009; Williams et al., 2003). Although minor modifications were necessary for specific participants in the present study (e.g., change in mask type to include a nose clip, modified definition of tolerance), the primary components of the treatment package (i.e., graduated exposure, prompts, and differential reinforcement) remained constant across participants. Additional research is needed to identify specific response patterns and participant characteristics that correspond to treatment efficacy without modifications.

The design of the present investigation, consistent with previous research (e.g., Sivaraman et al., 2020) did not evaluate whether our gradual exposure to steps of the hierarchy and all components of the treatment package were necessary. We could have conducted terminal probes during treatment and systematically introduced components of the treatment package, if necessary. Treatment time could have been saved or steps skipped had these procedures been included or systematically considered. Therefore, future researchers should investigate the use of terminal probes in treatment (e.g., after mastery of each target step). Nevertheless, we based our treatment package on empirically validated procedures for increasing tolerance of medical devices (e.g., Cox et al., 2017) and excluded terminal probes to avoid repeated exposure to baseline probes with escape for blocking and problem behavior.

The present investigation contained several other limitations. Three participants did not

complete the treatment package (Ryan, Kevin, George). One participant (George) discontinued participation to prioritize the assessment and treatment of severe problem behavior that occurred across clinical programs and at home. Further, Elias switched to telehealth partially through his treatment. Due to the need to progress through steps quickly based on Elias's quarantine, a probe of the terminal step was conducted partway through step 13 (of 15). At the time of the probe, Elias had already mastered nine steps during treatment, and his mom had shown she could implement the procedure with high integrity. Nevertheless, we could have measured generalization across settings and conducted terminal probes at specific points in training to prevent the necessity of this modification.

The duration of tolerance of facial coverings did not exceed 15 min (during the treatment extension) in the present investigation, and Sivaraman et al. (2020) evaluated tolerance of a face mask for 10 min. In addition, research also is needed to determine the prevalence of touching and licking face coverings in children with ASD who tolerate their use. Two participants (Javier and Ryan) in the present investigation frequently licked their face covering, one of whom (Ryan) saturated the face covering in saliva in less than 5 min. Further, therapists noted that participants had varying levels of touching the face covering during treatment. Based on health guidelines (CDC, 2020a), people should not touch face coverings while they are wearing them, unless proper hand hygiene is frequently and consistently used. Thus, extending previous suggestions for the reduction of face touching (e.g., Heinicke et al., 2020) to target a reduction in touching face coverings would advance the literature on behavioral interventions for children with ASD. Finally, research is also needed on appropriate donning and doffing of face coverings by children with ASD, as well as associated hand hygiene with face covering use (i.e. step 15 in the exposure hierarchy; Sivaraman et al., 2020).

REFERENCES

- Bergmann, S., Kodak, T., VanDenElzen, G., Jones, T., & Benitez, B. (2020). Efficacy and efficiency of auditory discrimination procedures for children with autism spectrum disorder and typical development: A preliminary investigation. Advance online publication. *European Journal of Behavior Analysis*. <https://doi.org/10.1080/15021149.2020.1795556>
- Brooks, J. T., Butler, J. C., & Redfield, R. R. (2020). Universal masking to prevent SARS-CoV-2 transmission—the time is now. *Journal of the American Medical Association*, *324*(7), 635–637. <https://www.doi.org/10.1001/jama.2020.13107>
- Carr, J. E., Nicolson, A. C., & Higbee, T. S. (2000). Evaluation of a brief multiple-stimulus preference assessment in a naturalistic context. *Journal of Applied Behavior Analysis*, *33*(3), 353–357. <https://doi.org/10.1901/jaba.2000.33-353>
- Centers for Disease Control and Prevention (2020a). How to select, wear, and clean your mask. <https://www.cdc.gov/coronavirus/2019-ncov/prevent-getting-sick/about-face-coverings.html>
- Centers for Disease Control and Prevention (2020b). CDC calls on Americans to wear masks to prevent COVID-19 spread. <https://www.cdc.gov/media/releases/2020/p0714-americans-to-wear-masks.html>
- Centers for Disease Control and Prevention (2020c). People with disabilities. <https://www.cdc.gov/coronavirus/2019-ncov/need-extra-precautions/people-with-disabilities.html>
- Cheng, V. C., Wong, S. C., Chuang, V. W., So, S. Y., Chen, J. H., Sridhar, S., To, K. K., Chan, J. F., Hung, I. F., Ho, P. L., & Yuen, K. Y. (2020). The role of community-wide wearing of face mask for control of coronavirus disease 2019 (COVID-19) epidemic due to SARS-CoV-2. *Journal of Infection*, *81*(1), 107–114. <https://doi.org/10.1016/j.jinf.2020.04.024>
- Cox, A. D., Virues-Ortega, J., Julio, F., & Martin, T. L. (2017). Establishing motion control in children with autism and intellectual disability: Applications for anatomical and functional MRI. *Journal of Applied Behavior Analysis*, *50*(1), 8–26. <http://dx.doi.org/10.1002/jaba.351>
- Dekker, M. C., & Koot, H. M. (2003). DSM-IV disorders in children with borderline to moderate intellectual disability. I: Prevalence and impact. *Journal of the American Academy of Child & Adolescent Psychiatry*, *42*(8), 915–922. <https://doi.org/10.1097/01.CHI.0000046892.27264.1A>
- Evans, D. W., Canavera, K., Kleinpeter, F. L., Maccubbin, E., & Taga, K. (2005). The fears, phobias, and anxieties of children with autism spectrum disorders and Down syndrome: Comparisons with developmentally and chronologically age matched children. *Child Psychiatry and Human Development*,

- 36(1), 3–26. <https://doi.org/10.1007/s10578-004-3619-x>
- Gillis, J. M., Hammond Natof, T., Lockshin, S. B., & Romanczyk, R. G. (2009). Fear of routine physical exams in children with autism spectrum disorders: Prevalence and intervention effectiveness. *Focus on Autism and Other Developmental Disabilities, 24*(3), 156–168. <https://doi.org/10.1177/1088357609338477>
- Hanney, N. M., Carr, J. E., & LeBlanc, L. A. (2019). Teaching children with autism spectrum disorder to tact auditory stimuli. *Journal of Applied Behavior Analysis, 52*(3), 733–738. <https://doi.org/10.1002/jaba.605>
- Heinicke, M., Stiede, J., Miltenberger, R., & Woods, D. (2020). Reducing risky behavior with habit reversal: A review of behavioral strategies to reduce habitual hand-to-head behavior. *Journal of Applied Behavior Analysis, 53*(3), 1225–1236. <https://doi.org/10.1002/jaba.745>
- Iwata, B. A., Pace, G. M., Kalsher, M. J., Cowdery, G. E., & Cataldo, M. F. (1990). Experimental analysis and extinction of self-injurious escape behavior. *Journal of Applied Behavior Analysis, 23*(1), 11–27. <https://doi.org/10.1901/jaba.1990.23-11>
- Kisamore, A. N., Karsten, A. M., & Mann, C. C. (2016). Teaching multiply controlled intraverbals to children and adolescents with autism spectrum disorders. *Journal of Applied Behavior Analysis, 49*(4), 826–847. <https://doi.org/10.1002/jaba.344>
- Kupzyk, S., & Allen, K. D. (2019). A review of strategies to increase comfort and compliance with medical/dental routines in persons with intellectual and developmental disabilities. *Journal of Developmental and Physical Disabilities, 31*(2), 231–249. <https://doi.org/10.1007/s10882-018-09656-y>
- Liang, M., Gao, L., Cheng, C., Zhou, Q., Uy, J. P., Heiner, K., & Sun, C. (2020). Efficacy of face mask in preventing respiratory virus transmission: A systematic review and meta-analysis. *Travel Medicine and Infectious Disease, 101*751. <https://doi.org/10.1016/j.tmaid.2020.101751>
- Lillie, M. A., Harman, M. J., Hurd, M., & Smalley, M. R. (2021). Increasing passive compliance to wearing a facemask in children with Autism Spectrum Disorder. *Journal of Applied Behavior Analysis, 54*(2), 582–599. <https://doi.org/10.1002/jaba.829>
- Lyu, W., & Wehby, G. L. (2020). Community use of face masks and COVID-19: Evidence from a natural experiment of state mandates in the US: Study examines impact on COVID-19 growth rates associated with state government mandates requiring face mask use in public. *Health Affairs, 39*(8), 1419–1425. <https://doi.org/10.1377/hlthaff.2020.00818>
- Shabani, D. B., & Fisher, W. W. (2006). Stimulus fading and differential reinforcement for the treatment of needle phobia in a youth with autism. *Journal of Applied Behavior Analysis, 39*(4), 449–451. <https://doi.org/10.1901/jaba.2006.30-05>
- Shillingsburg, M. A., Bowen, C., Valentino, A. L., & Pierce, L. E. (2014). Mandts for information using “who?” and “which?” in the presence of establishing and abolishing operations. *Journal of Applied Behavior Analysis, 47*(1), 136–150. <https://doi.org/10.1002/jaba.101>
- Sivaraman M., Virues-Ortega, J., & Roeyers, H. (2020). Telehealth mask wearing training for children with autism during the COVID-19 pandemic. *Journal of Applied Behavior Analysis, 54*(1), 70–86. <https://doi.org/10.1002/jaba.802>
- Tiger, J. H., Fisher, W. W., Toussaint, K. A., & Kodak, T. (2009). Progressing from initially ambiguous functional analyses: Three case examples. *Research in Developmental Disabilities, 30*(5), 910–926. <https://doi.org/10.1016/j.ridd.2009.01.005>
- Williams, G., Perez-Gonzales, L. A., & Vogt, K. (2003). The role of specific consequences in the maintenance of three types of questions. *Journal of Applied Behavior Analysis, 36*(3), 285–296. <https://doi.org/10.1901/jaba.2003.36-285>

Received December 11, 2020
 Final acceptance March 13, 2021
 Action Editor, Matthew Normand

Supporting information

Additional Supporting Information may be found in the online version of this article at the publisher’s website.