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Evaluating a Graduated Exposure Treatment to Teach Mask Tolerance Among Children with Autism

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by

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We the undersigned committee hereby approve the attached dissertation, "Evaluating a Graduated Exposure Treatment to Teach Mask Tolerance Among Children with Autism" by Hallie Ertel.

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Abstract

Title: Evaluating a Graduated Exposure Treatment to Teach Mask Tolerance Among Children with Autism

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Due to the COVID-19 outbreak, the Center for Disease Control (CDC) recommends that everyone 2 years and older wear a mask while out in a community setting (CDC, 2020a). It is important for children to learn how to tolerate wearing a mask for long durations of time while out in the community. In the current study, which was comprised of 2 experiments, we implemented a graduated exposure procedure to teach mask wearing to 6 children diagnosed with Autism Spectrum Disorder (ASD). The purpose of experiment 1 was to evaluate the efficacy of a graduated exposure procedure to teach mask tolerance across various settings, with generalization probes in the community. The purpose of experiment 2 was to evaluate whether generalization of the procedure occurred specifically in a physician's office setting during well check procedures. During baseline, participants tolerated masks for anywhere from 0 s to 10 min. After treatment, all participants tolerated the mask for a duration of at least one hour, with maintenance probes indicating 4-5 hour mask tolerance. Further, all participants in experiment 2 were able to tolerate a mask in the physician's office during well check procedures. Additionally, telehealth parent training sessions were conducted to instruct caregivers how to implement graduated exposure procedures to teach mask tolerance. Data from a social validity survey indicated all parents found the training beneficial.

Keywords: mask tolerance, graduated exposure, autism spectrum disorder, COVID-19

Table of Contents

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Dedication

I dedicate my dissertation work to my family and friends.

A special feeling of gratitude to my parents, whose constant and unwavering support of my education, from Pre-K to Ph.D., means nothing less than the world to me. I am who I am and where I am because of your guidance and support. Thank you for the values you have instilled in me- especially perseverance.

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Chapter 1
Introduction

Evaluating a Graduated Exposure Treatment to Teach Mask Tolerance Among Children with Autism

The novel coronavirus outbreak (COVID-19) was declared a pandemic by the World Health Organization (WHO) on March 11th, 2020 (WHO, 2020a). As of October 5th, 2020, the novel coronavirus, severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) has caused over one million deaths and 34.8 million cases have been reported to the WHO worldwide (WHO, 2020b). The Americas remains one of the most affected areas in the world, accounting for 55% of all reported cases and 55% of all deaths, with the United States of America reporting over 550,000 total deaths (WHO, 2020b).

COVID-19 Literature Review

Various mitigation techniques have been implemented to attempt to slow down the spread of COVID-19. For example; mask wearing, social distancing, and contact tracing have all been implemented at some level across different regions. A few peer-reviewed studies have assessed the effectiveness of these mitigation techniques.

Zhang et al. (2020) conducted a large scale study on COVID-19 by analyzing transmission pathways and mitigation measures in three epicenters; Wuhan, China, Italy, and New York City (NYC), from January 23, 2020 to May 9, 2020. Researchers analyzed projection of pandemic trends prior to face covering mandates in Italy (April 6) and NYC (April 17) by establishing a linear correlation between infection number and date. Their analysis revealed that mandated face coverings represent the determinant in shaping pandemic trends. Researchers found that mandated face masks alone significantly reduced the number of infections across epicenters. Mask wearing reduced COVID-19 cases by over 75,000 in Italy (from April 6th to May 9th) and by over 66,000 in New York City (from April 17th to May 9th). Reduced cases were not reported for Wuhan, China. However, researchers noted mandated mask wearing was implemented simultaneously with other mitigation techniques in China (i.e., mandated quarantining) making it difficult to isolate the effects of mask wearing alone. The researchers also stated that other techniques, such as social distancing, are insufficient by themselves. Researchers concluded that mandated wearing of face masks in public is the most effective means to prevent transmission of COVID-19. The authors note that other mitigation techniques (quarantining, social distancing, contact tracing) should be used simultaneously with mask wearing.

Similar results were found by Lyu and Wehby (2020) who analyzed the community use of face masks, across 15 different states and Washington D.C., and the spread of COVID-19. Authors conducted an event study and identified the effects of state mandates of public mask use between Aril 8th and May 15th, 2020. Their study focused on states that issued executive orders or directives signed by governors that mandate mask use in public. States that followed recommendations of guidelines from state departments of public health were not included, as these did not necessarily require mask wearing. Researchers primarily used publicly available daily county-level data of confirmed COVID-19 cases. The sample included data from 2,930 counties across the 15 states plus Washington D.C. Pre-post mandate changes in reported COVID-19 cases were analyzed in states with masking mandates. To obtain a daily growth rate, researchers calculated the natural log of cumulative COVID-19 cases on a given day, minus the natural log of cumulative cases the prior day, and multiplied by 100. This measure yielded the daily growth rate in percentage points. Reference periods for COVID-19 cases were 1-5 days before signing of the executive order. Researchers found that there was a significant decline in daily COVID-19 growth rate after the mandating of masking in public, with the effect increasing over time after the orders were signed. The daily rate declined by 0.9, 1.1, 1.4, 1.7, and 2.0 percentage points over the course of the 21 day experiment. All declines were found to be statistically significant ($p < 0.05$ or less). The number of averted cases was projected by comparing cumulative daily cases with daily cases predicted by the model if no states had enacted an executive order. The authors report that the model estimated 230,000-450,000 cases may have been averted due to masking in public. A main limitation of this study is researchers were unable to assess community compliance to the mandate, and to what extent the mandate was enforced in public. Additionally, early declines in the growth rate of COIVD-19 when masking mandates took effect also coincided with other mitigation techniques such as social distancing and the closing of businesses. The authors conclude that the results of this study provide evidence for mask wearing among the public to help slow the spread of COVID-19, and to help reduce cases during secondary and tertiary waves of the virus.

A study on reducing secondary transmission of COVID-19 within households was conducted by Wang et al. (2020). A cohort of 335 people in 124 families were recruited from Beijing, China. To be included in the study at least one person in the household had to have laboratory confirmed COVID-19. Their primary dependent variable was secondary transmission of the virus to another family member within the same household. Researchers analyzed characteristics of the primary case, well family contacts, and household hygiene practices as predictors of secondary transmission. Their results suggested that face mask use by the primary case and family contacts before the primary case developed symptoms was 79% effective in reducing transmission (OR = 0.21, 95%, CI 0.06 to 0.79). Daily use of disinfectants was 77% effective (OR=0.23, 95% CI 0.07 to 0.84). Wearing a mask post illness onset of the primary case was not significantly protective. This study provides evidence for the possibility of mitigating the spread of the virus by continuous mask wearing, as mask wearing post primary case confirmation was not as effective at preventing transmission.

MacIntyre et al. (2020) conducted a rapid systematic review of the efficacy of face masks in community and health care settings based on data published between March 1st, 2020 through April 17th, 2020. Studies that there were not randomized control trials, about anesthesia, or not about the prevention of the infection were excluded. Their search yielded 602 papers on Medline and 250 on Embase. From those, 820 were excluded based on title and abstract review. Full texts were reviewed for 32 studies and, from those, 19 were selected for their final review. The 19 randomized controlled trials were conducted across community, healthcare, and control settings. From the trials conducted in the community setting, researchers found masks to be effective both with and without hand hygiene measures. The researchers suggested community masking by well people could be beneficial to help mitigate the spread of COVID-19 where transmission could be pre-symptomatic. Chu et al. (2020) also conducted a systematic review to assess optimum distance for avoiding virus transmission, and the use of face masks to prevent virus transmission. Data were obtained for the spread of COVID-19 and the betacoronaviruses that cause severe acute respiratory syndrome (SARS) and Middle East respiratory syndrome (MERS). Their findings from the review of 172 studies provide evidence that at least 1 m physical distancing is associated with reduction in infection, and a distance of 2 m may be more effective. Additionally, their findings suggest wearing a face mask protects people (from the public population and healthcare workers) against infection by these coronaviruses. The authors did note that none of these interventions resulted in complete protection from the viruses.

Given the data from the studies above, and the recommendations from the CDC and WHO, wearing a mask could help to mitigate the spread of COVID-19. However, for some children, wearing a mask for long durations of time may be an unfamiliar experience. This may be especially true for children who have an intellectual disability, for whom mask wearing may be uncomfortable and difficult to tolerate due to the novel sensory experience of having a covering over the nose and mouth. Despite the uncomfortable sensation that may be associated with wearing a mask, it is still critical for children to learn how to tolerate wearing a mask.

To date, no behaviorally based study has assessed a technique to help promote mask tolerance for extended durations of time. However, a number of studies on increasing tolerance to medical procedures have been conducted. Interventions from this research literature have assisted in promoting compliance to aversive procedures. While mask tolerance may not be a “procedure” that is undergone, similar to a blood draw or physical exam, it can still be conceptualized as a noninvasive aversive experience. A number of interventions within the medical tolerance literature have addressed this topic.

Behaviorally based treatments in the medical tolerance research literature include graduated exposure, reinforcement, behavioral momentum, escape extinction, video modeling, and in vivo modeling. These methodologies have been applied to medical routines including dental examinations, physical examinations, blood draws, nebulizer treatments, and needle pricks, to name a few. The following section provides a review of these studies according to application. Studies are categorized based on whether they targeted medical or dental procedures, and whether the procedure was invasive or noninvasive. Invasive refers to the procedure requiring penetration of the skin.

Chapter 2
Treatments for Problem Behavior Evoked by Medical Care Routines

Noninvasive Medical Procedure Studies

Reimers et al. (1988) conducted a study to enhance compliance to a nebulizer treatment for a 2-year-old male. Due to a chronic lung disease, the participant was required to use a nebulizer for 20 min a day. However, he displayed problem behavior and refusal to wear his mask. The terminal criterion for mask wearing was 20 min. Treatment consisted of providing reinforcement contingent on successive approximations to the total time required to wear the mask and extinction for all mask removal behavior. Small increases were implemented once the participant demonstrated success at the current level (e.g., 30 s to 1 min). By the end of treatment, the participant was successfully wearing his mask for all 20 min. Additionally, a 3 month follow up probe showed maintenance of treatment effects. This is one of the only studies that used a duration based graduated exposure procedure. The authors did not include specifics on how their hierarchy was structured. Instead, it was stated that the duration requirement was increased each time problem behavior was stabilized at low levels. Therefore, it is difficult to determine exact training steps that authors used in their hierarchy.

Beck et al. (2005), taught eight children with attention deficit hyperactivity disorder (ADHD) how to swallow pills. Treatment involved systematic desensitization in the form of increasing the size of the placebo pills and providing reinforcement contingent on the participant swallowing the pill. By the end of treatment, seven out of the eight children swallowed the target size medication with the therapist. Additionally, six out of the eight participants demonstrated maintenance of treatment gains during follow up probes.

Gillis et al. (2009) evaluated a treatment package to decrease fear-related behaviors to instruments and procedures commonly used in basic physical medical examinations. Their treatment package consisted of reinforcement, modeling, and graduated in vivo exposure. Participants were 18 individuals diagnosed with autism spectrum disorder (ASD) whose mean age was 8.4 years. Behavioral observations were conducted in the school nurse's office. Fear-based behaviors were defined as (a) refusing to enter the nurses office, (b), pushing medical instruments away or attempting to throw them, (c), elopement (running away), (d) and vocal avoidant or escape behaviors such as screaming and crying. The intervention was individualized based on the results of a baseline assessment phase. That is, the number of medical instruments and steps in the graduated exposure hierarchy differed for each participant. To move to the next step in the hierarchy, the participant had to display none of the aforementioned avoidant behaviors. Positive reinforcement was provided for compliance to each step in the hierarchy. The final step of each participant's hierarchy was a 15 min physical examination in the nurse's office. Results showed that 15 of the 18 participants met final physical examination criteria within 25 sessions.

DeMore et al. (2009) implemented behaviorally based procedures to evaluate their effects on compliance to an overnight electroencephalograph (EEG) procedure. Participants included 17 children with developmental disabilities (ages ranging from 4-17 years). The treatment included a task analysis (12 steps), differential reinforcement of alternative behavior (DRA) and escape extinction. The task analysis was developed to facilitate teaching the steps of the EEG to the children. It was developed based on clinical experience of the authors, in addition to collaboration with EEG technicians. Positive reinforcement was provided contingent on compliance to each step. As part of the DRA, reinforcers were withheld contingent on instances of noncompliance (i.e., blocking the placement of electrodes). Escape extinction was employed to prevent children from escaping the task. Specifically, participants were blocked from removing the electrodes via a hands-down procedure. During training, nine participants tolerated all of the training steps and eight tolerated 75% of the steps of the task analysis. Training sessions were always conducted the day before test sessions. Additionally, both training and test sessions occurred in the same room. During the actual EEG, 15 of the participants tolerated placement of all 21 electrodes while the remaining two tolerated placement of nine electrodes. EEG data were collected, on average, for nine hours for each participant. The authors hypothesize that not all participants were able to tolerate placement of all electrodes due to time constraints surrounding their training procedures. Training sessions had to be conducted within one hour, due to availability of the training location. Given that there were time limits on training sessions, not all participants were trained to 100% compliance on the task analysis prior to the EEG test sessions. For example, some participants were only trained to tolerate 12 electrodes instead of the full 21 electrodes. The authors suggest that future research look at training all steps before observing compliance to the final exam.

Cuvo et al. (2010b) examined the effects of a multi-component intervention on compliance during a physical exam. Participants were six children (3- 6 years of age) diagnosed with ASD. All children were previously receiving autism services at a university based clinic. A medical office in the Physician Assistant (PA) program on the university campus was used for pre and post-test probes. Intervention training was conducted in the clinic where the children typically received services. The treatment hierarchy was designed by the PA and consisted of ten components (i.e., lung exam, heart exam, throat exam, and ear exam). The treatment package consisted of a priming video model, photo prompts, contact desensitization, shaping, DRO, and escape extinction. The video model was shown to the participants daily during training sessions. It depicted a typical peer undergoing the examination. Photo prompts were shown at the beginning of each training session. The experimenter presented a picture of the corresponding step in the hierarchy and the accompanying verbal instruction. Contact desensitization was described as fading in exposure to an aversive stimulus. Proximity to the aversive stimulus was faded while the participant had access to a preferred item. Shaping was used when lack of compliance was believed to be a skill deficit. For example, if the child did not know how to take six deep breaths during the lung exam, the response was shaped from one to six breathes. The researchers note that shaping sessions never took more than 5 min. Escape extinction was used as a consequence when a participant engaged in an escape behavior. When this occurred, the aversive stimulus remained present until the child tolerated it for 10 s. A physical exam posttest was completed on all 10 steps in the hierarchy by a PA. During baseline, participants complied with zero to three steps in the hierarchy. Following intervention, all participants demonstrated 100% compliance to hierarchy steps.

Posttest results for participants were variable. For three out of the six participants data indicated compliance to posttest exams with the PA. Three out of the six participants demonstrated noncompliance and problem behavior to the hierarchy steps. For example, one participant complied with only three steps and another participant refused to open his mouth during the posttest exam. One participant did not tolerate any hierarchy steps which were previously mastered in the clinic. Experimenters conducted additional training sessions with this participant in the medical clinic setting. Following this additional training in the medical office, he was able to tolerate all ten hierarchy steps. No data are provided on how long the retraining took or how many steps of the hierarchy experimenters retrained.

Riviere et al. (2011) evaluated the effectiveness of the high-probability (high-p) request sequence as a means of increasing compliance to medical examination tasks. Participants were two boys diagnosed with ASD who had a history of noncompliance to medical and dental requests. Compliance was defined as completing the low-p request within ten s of experimenter instruction. Low-p tasks were related to examining the participant's mouth, ears, and feet. High-p tasks were requests that occasioned 80% compliance or greater. Three high-p tasks were presented prior to the low-p task. First, the high-p sequence intervention was examined with the participant's mother, then with a medical professional, then at a leaner reinforcement schedule. Sessions were conducted in the participants' houses with the researcher or primary caregiver. Following in-home sessions, the high-p intervention was then tested with a medical professional in medical offices. Results showed that the high-p sequence increased compliance to all tasks across both participants when conducted by the researcher and primary caregiver. However, compliance decreased in the medical office setting when the high-p sequence was conducted by the medical professional. High levels of compliance maintained when the reinforcement schedule was thinned in the home setting. The reinforcement schedule was not thinned in the medical setting because compliance did not increase to levels as high as those compared to in-home sessions.

Similar results were found by McComas et al. (1998) who evaluated the use of the high-p request sequence to increase compliance to the instruction “hold still” while the participant’s mother cleaned his central-venous line (c-line). The participant was a 22-month-old male with developmental delays and severe self-injurious behavior (SIB). The participant received ongoing treatment at a hospital due to short-bowel syndrome. All experimental sessions were conducted in the participant’s crib in the hospital room. Compliance to the instruction “hold still” was defined as the participant lying on his back without moving his torso or legs for 5 s. Two treatment packages were implemented to increase compliance to the low-p request: DRA with escape extinction and the high-p sequence combined with DRA and extinction. The participant’s mother conducted all sessions. A list of steps to sterilize the c-line was given to the mother prior to all experimental sessions (11 steps). Prior to implementing each step, the mother would issue the instruction “hold still”. If the participant complied then the mother played with the participant for approximately 5 s (DRA). If the participant did not comply, researchers held the participant until the step was completed (escape extinction). During steps with the high-p intervention, three to five high-p requests were issued prior to issuing the low probability (low-p) request. Compliance to the high-p requests resulted in praise. Results showed that high-p with DRA and escape extinction was more effective (increased to 100% compliance) than DRA with escape extinction alone (increased to 25% compliance). The authors hypothesize a greater increase in compliance during the high-p intervention may be due to greater rates of reinforcement with this intervention as compared to DRA alone.

Wolff and Symons (2013) evaluated a multi-component exposure treatment package to treat noncompliance to needle pricks in a 41-year-old male with autism who lived in a group home. The participant engaged in escape/avoidant behaviors during routine medical care that involved a needle (i.e., injections and blood draws). Intervention included needle exposure therapy (based on Hagopian et al., 2001) which was comprised of stimulus fading (distance of needle to participant) plus DRA. If the participant displayed compliance by keeping his arm on the table for 10-15 s, the experimenter with the needle then moved out of view and the experimenter sitting next to the participant delivered a reinforcer. If the participant displayed noncompliant behavior, no reinforcer was delivered and the experimenter with the needle stayed in sight. This was repeated until the experimenter with the needle was zero feet away and needle to skin contact was made. The goal was met after 88 trials. Data were collected on the number of trials the participant met criterion to move to a shorter distance (average of three trials). However, no data were collected on noncompliant behavior exhibited by the participant during each trial. Additionally, the terminal goal of the study was needle to skin contact; no attempts were made to address needle injection into the skin.

Cavalari et al. (2013) used a treatment package to teach an adolescent female with autism to tolerate a routine medical examination. Intervention consisted of a 12-step exposure hierarchy with reinforcement for appropriate behavior. Compliance was defined as the participant completing a step in the hierarchy without withdrawing any part of her body, demonstrating problem behavior, or attempting to leave the examination room. Vocal protests did not count as noncompliant behavior. All sessions were conducted in the same examination room. Example steps in the hierarchy with which the participant had to comply included blood pressure measurements, a lung exam, a heart exam, and an abdominal exam. In total, there were 12 steps in the hierarchy with which the individual had to comply (eight of which had sub steps). Prior to graduated exposure, an experimenter modeled appropriate behavior for the participant. Compliance to each step resulted in praise and a preferred edible. Results showed that the participant displayed compliance to each procedure within the targeted criterion steps except for one phase, which required extended acquisition training (complying with blood pressure measurements). Researchers demonstrated that graduated exposure and reinforcement alone increased compliance to a multi-step medical hierarchy. A drawback of this study was that only one individual participated and there were no maintenance or generalization probes conducted.

Thus far in the literature, there have been nine studies conducted on methods to increase compliance to noninvasive medical procedures. Even though most studies utilized intervention packages which incorporated different methodologies, all studies incorporated graduated exposure to a task analysis or hierarchy of training steps. Additionally, only two studies (Cuvo et al., 2010b; Riviere et al., 2011) attempted to study effects on compliance across settings. In Riviere et al. (2011), the authors observed compliance to multi-step medical examination tasks in home and in a medical office. Their results showed that both participants' compliance increased in the home setting with researchers and primary caregivers. However, compliance decreased in the medical office with a medical professional. These data suggest measures should be taken to ensure compliance remains high during actual testing of the trained procedure in the medical context. In Cuvo et al. (2010b), compliance was measured to a physical examination hierarchy. Treatment was conducted in a clinic setting, then tested in a medical office. Three out of the six participants displayed compliance in the medical office. Three participants displayed noncompliance and problem behavior when in the medical office, despite mastering these steps in a different setting. Interestingly, for the participant who displayed 0% compliance in the medical office, a retraining of steps in that setting resulted in an increase of compliance to 100% during the next probe. These data suggest that training in the clinic context may be insufficient when final examination testing occurs in a different context (medical office). In both studies, no data were collected on similarity of environmental stimuli from training context (in home) to the final test context (medical office).

Invasive Medical Procedure Studies

Hagopian et al. (2001) evaluated a multicomponent intervention to teach compliance to blood draws for a 19-year-old male with moderate developmental delays. Treatment consisted of fading, modeling, noncontingent access to preferred items, and a 10 s DRA for compliance. The participant engaged in severe problem behavior which included property destruction and aggression. At the time of the study, he was taking five different psychotropic medications targeting his property destruction and aggression. He also met DSM-IV criteria for specific phobia, blood-injury-injection subtype. He exhibited responses such as shaking, sweating, and avoidance when told he had to receive a blood injection or blood draw. The participant needed frequent blood draws to monitor his medical status due to a kidney reflux diagnosis and accurate therapeutic dosing. The goal of treatment was to have the participant independently enter a nurse's office when instructed and sit calmly during the procedure. Data were taken on problem behavior exhibited during the medical procedure and compliance (defined as absence of problem behavior) to each step in the hierarchy. A 10-s DRA procedure involved the delivery of social praise and tokens, which he could trade in at the completion of session. If the participant displayed escape behavior, the researcher modeled the appropriate step. Due to the participant's severe problem behavior, a papoose (restraint board) was used to expose him to higher steps in the hierarchy. The level of restraint used with the papoose was faded over trials. All sessions were conducted in the same setting. Results showed that after 50 treatment sessions the participant was able to complete all steps in the hierarchy independently. However, a limitation of this study was that due to the high intensity of the participant's aggressive behavior, the use of an acute dose of an anxiolytic medication (Xanax) could not be faded.

Shabani and Fisher (2006) assessed stimulus fading and differential reinforcement of other behavior (DRO) to treat problem behavior displayed during blood withdraws by an 18-year-old male diagnosed with autism and Type 2 diabetes. All sessions were conducted in a treatment room at an outpatient clinic.

During baseline, the participant consistently moved his hand away from the posterboard outline. During treatment, the participant was required to keep his hand horizontally positioned within an outline on a posterboard. If he did so for 10 s then he received access to his highest preferred edible item. Contingent on keeping his arm in place, the distance between his fingertips and a lancet was shortened. If he moved his arm more than 3 cm from the outline then the trial was immediately terminated, all materials were removed, and the experimenter turned away for 10 s. During treatment, he kept his hand and arm within the outline on an average of 97% of all treatment trials. Two-month maintenance probes indicated that compliance remained high to the percentage of correct trials in the hierarchy (100%). A limitation authors note in their study is how they only collected data on compliance and avoidance (arm removal) responses. They suggest that going forward, data should be collected on "distress responses" as well. Distress responses refer to behavior such as crying, screaming, property destruction, or aggression.

Based on these recommendations, Slifer et al. (2011) conducted a similar study on treatment of problem behavior during needle stick procedures, taking into consideration distress responses. Participants were eight children with intellectual and developmental disabilities who displayed noncompliance to needle prick treatments. Treatment consisted of a multicomponent treatment package which incorporated graduated exposure, distraction techniques, and mock needle pricks. For all participants, results showed that compliance to actual needle pricks increased and distress behavior decreased.

Davit et al. (2011) conducted a study to improve venipuncture compliance for children with ASD. Venipuncture involves the act of puncturing a vein as part of a medical procedure, typically to draw a blood sample. Participants were 58 children with a diagnosis of ASD (0-20 years of age). Intervention included a social story, reinforcement for compliance, and a picture schedule. Additionally, researchers developed the Blood Draw Intervention Protocol (BDIP), which is an individualized tool to help gradually increase exposure to the feared stimulus. The BDIP is practiced at home with parents before the actual visit for a blood draw. This tool was developed in the interest of keeping the duration of the medical visit short. The BDIP consisted of five components; instructions for the parent, instructions for the child, an individualized social story integrating a parent-chosen reinforcer, a picture schedule which depicted when the reinforcer would be achieved during the blood draw, and a packet of venipuncture materials (rubber gloves, alcohol swabs, band-aids, elastic tourniquets, and 5ml plastic syringe). Parents were given instructions on the BDIP. Specifically, they were told how to read the social story to their child, and were told when the picture schedule indicated receiving reinforcement contingent on compliance. The BDIP was practiced in home with parents to mastery criteria (completion of all exposure steps) then, data were collected on compliance during an actual blood draw with a nurse. A successful blood draw was defined as the patient being able to provide a sufficient blood sample for testing. Results indicated that 96.6% of the 58 participants were able to provide a sufficient amount of blood during the blood draw. However, it should be noted that these participants were taken from a sample of participants going through a larger genetic testing study (n = 239); 85.4% of these participants could already provide a sufficient amount of blood. Two hundred and ten families were offered the BDIP and 58 agreed to use it. From the sample of 210 families, 94.8% could already provide a sufficient amount of blood. Measures were not taken to ensure that the remaining 5.2% of participants who could provide a sufficient amount of blood were included in the current study. Therefore, it is difficult to determine if the BDIP improved compliance to blood draws for the 58 participants, or if this was a skill the participants had prior to intervention. Additionally, social validity responses indicated that, overall, parents liked the service being offered and did not find it too time consuming to implement at home.

A similar study was conducted by Grider et al. (2012) in which researchers attempted to increase compliance to a blood withdraw for a 21-year-old male. The participant had to undergo frequent blood draws to properly measure therapeutic levels of medication. All sessions occurred in the school nurse’s office (across baseline, intervention, and postintervention). The intervention consisted of graduated exposure, positive reinforcement, and stimulus distraction. Social reinforcement was provided contingent on compliance to each of the 12 steps in the exposure hierarchy. If the participant physically resisted a step then the trial was stopped immediately. Two to three five min trials were conducted per day. The task analysis had to be modified slightly during intervention after assessment revealed that the participant needed exposure trials to the syringe alone with no needle attached. Results showed that after 33 trials the participant was able to tolerate 100% of the steps involved in the exposure hierarchy. Additionally, postintervention probes revealed 100% compliance to the procedure one month following intervention.

In summary, five studies have been conducted using behavioral methodology to increase compliance to invasive medical procedures. Similar to the noninvasive studies, graduated exposure to a medical hierarchy was the most commonly implemented intervention. Only one study (Davit et al., 2011) examined effects on compliance when the final medical test was conducted outside of the training context. Even though authors report an increase in compliance in the medical setting, these results may be skewed because participants were pulled from a sample of individuals who could already demonstrate compliance to the procedure (94.8%). Therefore, future research needs to be conducted in which participants have exhibited no compliance to the medical procedure prior to intervention. Another limitation of this study is that no measures were taken to examine similarity of stimuli across treatment and test contexts.

Noninvasive Dental Procedure Studies

Allen and Stokes (1987) implemented an escape and reinforcement-based treatment to decrease problem behavior during a dental cleaning. Participants were five children (3 to 6 years of age) who displayed problem behavior during dental visits. All sessions occurred in a dental office. Contingent on compliance to steps in a dental cleaning, the participant was allowed to escape the procedure. Additionally, they were praised and given access to preferred stickers. Disruptive behavior data were collected using 15 s partial interval recording. Baseline levels of problem behavior averaged about 90% per participant. Following treatment, problem behavior data averaged about 15% by the final visit. Additional results indicated that the treatment was effective at reducing participant’s overall heart rate and blood pressure during the dental visit. Subjective report measures from the dentist indicated that all participants were more cooperative and relaxed during the procedure following treatment implementation.

Stark et al. (1989) evaluated the efficacy of a distraction-based technique on problem behavior during dental treatment. Participants were four male children (4 to 7 years of age) who were referred from a university dentistry program for exhibiting high levels of disruptive behavior. The authors refined the Anxious and Disruptive Behavior Code (ADBC) (developed by Allen & Stokes, 1980). The four categories of the ADBC include head movement, body movement, complaining, and restraint. Data were scored using 15 s partial interval recording. Heart rate and blood pressure were also automatically taken every two min using a vital monitoring device. Dental work during treatment was performed by researchers involved in the study. Dental work during a postintervention assessment was conducted by dentists. Procedures during baseline were described as those typically followed during a dental visit. If the child did not comply then, the researcher would stop the procedure or restraint was used. Posters and audio recorded stories were used as the distractor stimuli during treatment. Posters were described as colorful and presented unusual scenes (e.g., outer space). They were hung above the dental chair for the child to look at during treatment. An audio story was played simultaneously via headphones the child was wearing during the procedure. At the end of the appointment, the child was given a quiz about the audio story they had just listened to. If he scored 65% or higher than he was allowed to choose a preferred item. The quiz at the end of the appointment ensured that the child attended to the audio story during the dental procedure. Results showed that overall distraction, even when paired with a reinforcement contingency, did not appear to be an optimal intervention strategy. For all participants, disruptive behavior initially decreased upon intervention implementation. However, for two participants, disruptive behavior increased across successive visits. Additionally, during the post-intervention assessment conducted by a dentist, the dentist reported participants to be “more anxious” compared to baseline measures. Authors also report there were no noticeable differences in heart rate or blood pressure from baseline to intervention. In sum, although the procedure was initially effective, the results did not maintain across treatment or follow-up assessment.

Altabet (2002) conducted a between subjects group design study to compare the effects of systematic desensitization on problem behavior during a routine dental cleaning. Thirty five individuals with disabilities were assigned to the treatment group and 28 individuals with disabilities were assigned to a control group. Participants in the treatment group were gradually exposed to increasingly intrusive steps in an individualized hierarchy. Hierarchy steps ranged from initial instruction about visiting the dentist to tolerating dental equipment being placed on the teeth. Participants were gradually exposed to the hierarchy using modeling, shaping, paired relaxation, and reinforcement. Treatment was continued until the participant could complete the entire hierarchy with no more than verbal prompting for three sessions in a row (an average of three months per participant). Dependent variables were number of steps in the hierarchy completed, use of restraint, and use of sedation. Participants in the treatment group were observed undergoing an actual cleaning at the dentist office following mastery of all steps in the clinic. Observations for the control group were about 3 months apart (average mastery time for the treatment group). Results showed that 54% of the individuals in the treatment group showed an increase in the number of steps completed during the dental visit (despite all participants previously mastering the hierarchy). There was a 21% increase in steps completed for the control group during the dental visit. Statistical analysis showed that participants in the treatment group gained an average of one step in the hierarchy during the final visit. Participants in the control group gained an average of .2 steps completed correctly during the visit. While there were no direct data collected on problem behavior, results showed that differences in sedation and restraint were not significant for either group.

Neumann et al. (2000) evaluated the effects of video modeling and in vivo desensitization on treating three dental phobic adults with disabilities. After treatment, all 3 participants were able to tolerate the dental procedure. However, researchers used a treatment package so it was unknown which component of the intervention was most effective. Therefore, Conyers et al. (2004) assessed the effectiveness of in vivo desensitization and video modeling separately on compliance to dental procedures. Participants were six individuals diagnosed with a developmental disability (43 to 47 years of age). Prior to intervention, all six participants needed anxiolytic medication and/or leg and arm restraints. Baseline, in vivo desensitization, and probe sessions were conducted at a dental school at a dental office. The dental office contained a dental chair and various dental equipment and instruments. Video modeling was conducted in an assessment room that contained a chair, desk, and VCR player. Three participants received the in vivo intervention and three received the video modeling intervention. Compliance was defined as engaging in the behavior specified in each step of the task analysis. During baseline and probe sessions, participants progressed through the hierarchy until she or he refused to continue. In vivo desensitization was similar to baseline with the addition of positive praise for completing each step in the hierarchy. In the video modeling condition, the participant watched a 15 min video of a well-known person completing all steps in the task analysis. Probes were conducted about once a week per client (after an average of 3-4 steps mastered). Results showed that in vivo desensitization was effective for all three participants in that group while video modeling was effective for one out of the three participants in that group. A limitation of the study was that researchers were not able to formally evaluate the effectiveness of in vivo desensitization during an actual dental cleaning procedure. However, three of the participants (two of which were exposed to in vivo desensitization) underwent a cleaning and were described as being more cooperative by the dental staff.

Cuvo et al. (2010a) evaluated a procedure to train children with ASD how to be compliant during an eight step oral assessment. Participants were five children diagnosed with ASD who displayed noncompliance to dental procedures. Experimental sessions were conducted in a dental office located on a university campus. Researchers targeted decreasing escape maintained behavior, which included throwing, hitting, kicking, spitting, verbal refusal, whining, and crying. Researchers also targeted increasing compliance, which was defined as the participant tolerating the dentist or experimenter performing a procedure without emitting an escape/ avoidance behavior and emitting an appropriate response within ten s of the instruction. The first step of intervention involved parents showing their child a priming video model daily during training sessions. A treatment package consisted of stimulus fading, distraction, photo prompts, differential reinforcement, and escape extinction. A step in the hierarchy was considered mastered when the participant complied with the step for three consecutive trials. If the participant did not comply then escape extinction was implemented on that step. If the participant complied with three steps in a row then a baseline probe was conducted. If steps were complied with during the baseline probe that had not yet been trained, the next target step was the one during which noncompliance occurred in the baseline probe. Results showed all five children displayed increased compliance levels to the oral assessment during treatment compared to baseline levels of compliance.

While procedures were found to be effective, all treatments were implemented as a package so it remains unclear as to whether the entire package was necessary for compliance to the procedure, or whether a component(s) of the treatment package was more effective than others. Additionally, all participants were exposed to an oral assessment posttest. During the posttest a dental hygienist completed the cleaning in a dental office. Four out of the five participants demonstrated problem behavior during the oral assessment posttest, despite that fact that all steps had been previously mastered (without problem behavior) in a different setting.

Recently, Hine et al. (2019) evaluated a video modeling intervention to decrease disruptive behavior during dental visits. Forty participants (3-6 years old) were recruited from a sample of patients seen at a dental clinic. Participants were randomized into two groups. Prior to the dental exam, one group watched a brief video model depicting the steps of the following dental procedure, and another group watched a control video. The setting was the same throughout the duration of the study. Disruptive behavior included both physical and vocal disruptions. Results showed that the treatment group had a significantly lower mean percentage of intervals in which disruptive behavior occurred compared to the control group. Also, subjective rating measures obtained from dentists indicated higher ratings of cooperation among the treatment group.

In summary, six studies have looked at using behaviorally-based interventions to increase compliance during noninvasive dental procedures. The most common intervention across all studies was graduated exposure. Two studies (Altabet, 2002; Cuvo et al., 2010a) examined the efficacy of the graduated exposure intervention across clinic and medical office settings. Cuvo et al. (2010a) showed that four out of the five participants displayed problem behavior in the medical office, despite mastering all steps without problem behavior in the clinic. Data from Alatabet (2002) revealed that 54% of the individuals who underwent treatment in a different setting increased hierarchy compliance by about one step while at the dentist office. These data suggest that additional training of hierarchy steps in the final test context might be necessary to see decreases in problem behavior during the final examination. Additionally, although no study explicitly mentions collecting data on context similarly, Neumann et al. (2000) detail how the practice dental office (desensitization group) contained equipment more similar to the final test environment compared to the environment where participants underwent video modeling training. Although this was not directly reported, two out of three participants who were reported to display higher compliance during a follow up examination underwent the in vivo desensitization treatment. The third participant, who was in the video modeling group, already displayed high levels of compliance during baseline. Further research in this area could potentially indicate a possible relationship between context similarity and compliance in an applied environment.

Invasive Dental Procedure Studies

One of the first studies on dental compliance was conducted by Stokes and Kennedy (1980). Participants were eight children enrolled in a government dental program. The study was conducted in a dental clinic located within a school building. Data were collected on uncooperative behavior during a restorative dental treatment procedure. An ADBC design was used to evaluate uncooperative behavior during 15 s partial interval recording. Baseline consisted of the dental nurse conducting all restorative procedures and providing praise contingent on compliance. Additionally, a "smile stamp" was provided noncontingently at the end of the appointment. During treatment, if the child displayed a low level of uncooperative behavior then they received a small preferred item at the end of the visit. Additionally, if the participant displayed a low level of uncooperative behavior then she or he was allowed to raise the next participant's dental chair. A third treatment component included the participant observing another child in the dental chair undergoing the same procedure. Results of the current study were similar to the results of Stark et al. (1989). There was an initial decrease in problem behavior, however, this behavior change did not maintain for five out the eight participants. For five participants, mean levels of uncooperative behavior (as indicated by the ADBC design) remained high across all visits to the dental clinic. The authors hypothesize problem behavior remained high because at restorative dental work often requires more time compared to regular dental work (e.g., a cleaning) and can be more intensive for the child.

O'Callaghan et al. (2006) examined the effects of noncontingent escape on decreasing problem behavior during a restorative dental surgery. Participants were five children (4 to 7 years of age) who displayed problem behavior during dental treatments. Participants were required to need at least three visits for tooth restoration in order to be included in the study. All baseline and treatment sessions were conducted in the dental office. Steps each participant had to tolerate during the procedure included: examination of the teeth that required restoration, applying topical anesthetic, injection of local anesthetic, mouth prop placement, tooth decay removal via drill, and placement of restorative piece (i.e., filling or crown). During baseline, the dentist continued through each step until the child displayed noncompliance. During treatment, the dentist was fitted with a MotivAider and instructed to follow standard procedures. The MotivAider was initially programmed to go off every 15 s. A researcher prompted the dentist to thin the schedule by 10 to 20 s increments based on low occurrences of problem behavior, until the terminal schedule (FT 1 min) was reached). Breaks were 10 s the first min of treatment, and 20 s following the first minute. During the break, the dentist removed all instruments and fingers from the child's mouth. Additionally, the participant was allowed to sit up and move around the room. All participants displayed high levels of problem behavior across baseline sessions. The noncontingent escape treatment resulted in a decrease of physical problem behavior for all five participants. Verbal disruptive behavior was reduced in four out of the five participants. Results showed that, overall, disruptive behavior occurred, on average, during less than 30% of sessions for all participants. Social validity data indicated that the dentists found the procedure easy to understand and implement. One limitation of this study was there was no systematic approach to schedule thinning. Thinning was subjectively determined by the researcher who sat in the room with the dentist. As a result of this, authors note the exact procedures they used cannot be replicated. Future research could examine a more objective way to thin the schedule of reinforcement.

Overall, two studies have been conducted on increasing compliance to restorative dental work. One study used a reinforcement and observation treatment, and the second evaluated noncontingent escape. Stokes and Kennedy (1980) found that the reinforcement and observation intervention was not effective for five out of their eight participants. O'Callaghan et al. (2006) reported that the noncontingent escape treatment was effective at reducing physical problem behavior for all five participants and, reducing verbal problem behavior for four out of five participants. Additionally, authors report that dentists found the noncontingent escape treatment easy to implement and comprehend. Neither study looked at conducting a follow up test in a different context from treatment. However, in O'Callaghan et al. (2006), treatment was conducted within a dental office initially.

Chapter 3
Limitations of Applied Research

Generalization of Treatment

While all of the experiments discussed in the review were met with some level of success, there are still large parts of the literature left unaddressed. First, in all but five studies, treatment was conducted in the same context in which the procedure was tested. That is, if the participant needed compliance training on tolerating steps involved in a physician check-up, all treatment sessions were conducted in the physician's office over the course of the study. This has implications for mask tolerance, as individuals are required to wear masks across a variety of settings (e.g., schools, therapy, grocery store, restaurants, doctors office, etc.).

For example, in DeMoore et al. (2009) participants received EEG tolerance training in the same room where the final EEG procedure occurred. Or, treatment was conducted in a clinic setting, then testing was conducted in that same clinic setting. While this is satisfactory for research purposes, outside of research, treatment for noncompliance to routine procedures typically occurs in one context (e.g., clinic) then is tested in a separate context (e.g., doctors office). For example, take an individual who displays noncompliance to blood pressure checks. Working on tolerating a blood pressure cuff might be built into the child's programming while at the clinic. Tolerance training typically does not occur on a daily basis in the medical office where the blood pressure test occurs. This is in part because clinics usually have a larger amount of time and resources to devote to treating problem behavior in the clinic setting. It is unlikely that caregivers have the time or training needed to take their child on a routine basis to the setting where the medical testing occurs.

A problem that arises is that behavioral treatment gains learned in one setting do not always generalize to other settings (Podlesnik et al., 2017). That is, even if an increase in compliance was observed in the clinic, it is likely that the problem behavior will re-occur in the test setting. When a child's problem behavior is treated in one setting (e.g., a clinic), and then there is a transfer to another setting (e.g., a hospital), the child is more likely to display the problem behavior that produced reinforcement in that context in the past (e.g., previously extinguished escape/avoidance behavior) (Fisher et al., 2015). For example, if mask tolerance was trained in a clinic setting, then tested in a grocery store, the child may not be able to wear the mask inside the grocery store. A longstanding problem in applied behavior analysis is that treatment effects established in one setting do not transfer to other contexts or therapists (Podlesnik et al., 2017).

This effect has been demonstrated in multiple studies with token economies (Kazdin & Bootzin, 1972), functional communication training (FCT) and self-control skills (Falcomata & Wacker, 2013; Luczynski et al., 2014), PICA (Hagopian et al., 2011), and even functional analysis (FA) based results for the same topography of problem behavior across different settings (Lang et al., 2010; Lang, et al., 2009; Lang et al., 2008).

This effect was demonstrated in the studies reviewed above that tested compliance in a different setting from where treatment occurred. Three medical compliance studies and two dental studies examined compliance across contexts. The results of Riviere et al. (2011) showed that compliance decreased when the procedure was tested in the physician's office with a physician. The results of Cuvo et al. (2010b) showed that for three out of six participants compliance decreased when tested in the medical office setting. One participant, despite mastery of the entire hierarchy in a clinic setting, demonstrated 0% compliance to the hierarchy in the medical setting. Davit et al. (2011) looked at compliance to blood draws across home and medical settings. Researchers reported an increase in compliance, however, participants were pulled from a sample of individuals who could already comply to blood draws. In the dental literature, two studies have examined compliance across contexts. Altabet (2002) found that only 54% of individuals who had undergone treatment in a different context increased compliance to the hierarchy in the dental context. Additionally, the increase in steps complied to was an average of one step. Cuvo et al. (2010a) found that problem behavior increased for four out of five participants when they returned to the dental office setting. Thus far in the literature, five studies have looked at compliance across settings. Four out of those five studies have found either decreased compliance or increased problem behavior in the final test setting. Taken together, these results suggest the need to examine how to increase compliance to medical/dental procedures when test and training occur in different contexts.

When possible, Allen and Kupzyk (2016) recommend inclusion of in vivo exposure as a component of treatment protocols. However, outside of research this can be difficult to plan for, as frequent visits to the medical office for treatment may be time intensive and costly (due to the billing required on behalf of the medical professional). Even though research has shown that problem behavior returns and compliance decreases upon testing the procedure in a medical office, there have been no measures taken to account for generalization of learning outside of the treatment context. Multiple context training is a technique that has been shown to be effective at decreasing renewal of problem behavior and increasing generalization of learning. This specific training technique could be utilized to help promote mask compliance across settings where compliance was not specifically trained. Before discussing multiple context training in greater detail, a brief review of renewal and the renewal literature is provided below to explain why the return of problem behavior is likely to occur across contexts.

Renewal

Renewal is characterized by a series of phases of reinforcement and extinction across contexts. In the renewal procedure, during phase one, a specific response is reinforced. In phases two and three of extinction, reinforcement is withheld and an extinction contingency is in place (Bouton et al., 2011). There are three main kinds of renewal; ABA, ABC, and AAB. In ABA renewal, contexts are similar in phases one and three. In ABC renewal, contexts are different across all three phases. In AAB renewal, contexts are similar in phases one and two but different in phase three (Bouton et al., 2011). In ABA renewal, typically, there is a return of the extinguished behavior in phase three (during a return to the original context). In ABC renewal, the effect of renewal can be observed when there is a change to a novel context, one that is different from reinforcement and extinction contexts. In AAB renewal, reinforcement and extinction occur in the same context, yet there is still a return of the extinguished behavior in a novel context (Bouton et al., 2011). Additionally, research shows that renewal effects can be seen in both respondent (Bouton et al., 2011) and operant (Podlesnik & Shahan, 2009) behavior. For example, Bouton et al. (2011) trained rats to lever press in a distinct environment (Context A). Researchers then extinguished lever pressing in an environment with different stimulus features (Context B). Lastly, when rats either returned to Context A, or to a novel environment (Context C), there was renewed responding of lever pressing, even though the extinction contingency was still in place. Reemergence of the target behavior in phase three of the renewal procedures reveals a strong influence of the role of contextual control over responding. Overall, renewal literature implies that simply a change in contexts is sufficient for a previously extinguished behavior to relapse.

Renewal literature has relevance for treating problem behavior across settings. Given that children travel to different contexts throughout the day (e.g., school, clinic, home) it is possible that behavior treated in one setting may still occur in a different setting. Kelley et al. (2015) provide an example for understanding renewal in a translational and basic application. These researchers conducted two experiments in which reinforcement for a target response was followed by two phases of extinction with similar contexts to baseline (ABA renewal). In the first experiment, researchers put six pigeons through an ABA renewal paradigm and measured key pecking across contexts. In the second experiment, two males diagnosed with autism (4 and 9-years old) served as the participants. To stimulate different contexts, researchers wore different colored shirts and hung corresponding colored poster boards on the wall. The target behavior was completion of previously mastered tasks. Similar to experiment one, both participants were exposed to an ABA renewal procedure. Results of experiment one showed that all pigeons demonstrated renewal of the target key pecking behavior in phase 3. Similar results were found with the child participants who displayed renewal of the target behavior in phase 3 as well. It is important to note that the effects in terms of form and magnitude were similar across the human and nonhuman participants. The results suggest generality of the processes that underlie renewal and offer a platform for assessing questions related to treatment maintenance with humans and behaviors of social significance. (Kelley et al., 2015).

Pritchard et al. (2016) assessed renewal of problem behavior in an adult male diagnosed with an intellectual disability. In context A, the participant was exposed to a two-component multiple schedule in which either a high or low magnitude of reinforcement was delivered depending on the schedule component in effect. In context B, reinforcement was discontinued across both schedule components. During the return to context A, even though the extinction contingency was still in effect, problem behavior re-emerged. These results demonstrate ABA renewal specifically with problem behavior. Additionally, the renewal of problem behavior was higher and more persistent in the condition associated with the high magnitude of reinforcement in phase 1.

Conhenour et al. (2018) added to the renewal literature by demonstrating AAB renewal of an operant behavior in children with ASD. Researchers taught a simple lever pull response, extinguished the response in the same setting, and then tested for renewal in a novel context. Results showed that lever pulling increased for two out of the three participants when novel stimuli where introduced. This study provides further evidence for the possibility of response recovery across contexts.

All studies discussed above provide evidence for the idea that human operant behavior maintained by positive reinforcement is susceptible to renewal. Additional renewal studies have examined whether human operant behavior maintained by negative reinforcement is also susceptible to renewal. Allessandri et al. (2015) demonstrated this effect by measuring key pressing on a keyboard with university students. In context A, key pressing was maintained according to a variable-ratio (VR) schedule of reinforcement. Participants were allowed a 3 s break from the effortful response of holding their finger on a key. In context B, pressing the key no longer provided access to a break from the effortful response. Upon the return to context A, there was an increase in key pressing despite the extinction contingency still in effect.

Kelley et al. (2018) added to the literature on socially significant operant behavior maintained by negative reinforcement. Specifically, researchers were looking at innapropriate mealtime behavior (IMB) and aggression. Kelley et al. (2018) extended this research by adding a differential reinforcement component (rather than extinction alone) in phase 2. This is important to assess because that alternative sources of reinforcement are usually available within the treatment context (Podlesnik et al., 2017). Participants were three males diagnosed with ASD and Avoidant/Restrictive Food Intake Disorder (ARFID). One participant participated in a functional analysis to ensure that IMB was escape maintained. In context A, any instance of IMB or aggression was met with 20 s of escape from the demand. In context B, 20 s of escape was provided contingent on instances of compliance. For the participants who engaged in IMB in context B, escape extinction was implemented. Both escape extinction and differential reinforcement of compliance contingencies were kept in place upon returning to context A; results showed that problem behavior re-emerged even though treatments continued. These results are important for a few reasons. First, researchers demonstrated that a socially significant behavior maintained by negative reinforcement is susceptible to renewal effects. Taken from Kelley et al. (2018); negative reinforcement accounts for 29.7% of functional analysis outcomes in the published literature in general (Beavers et al. 2013), for 26% of functional analysis outcomes in important clinical environments such as schools (Mueller et al. 2011), and for 90% of interpretable functional analyses of inappropriate mealtime behavior (Piazza et al., 2003). Given these statistics, it is important to continue to assess the effect of renewal on problem behavior maintained by negative reinforcement. Second, results showed that problem behavior re-emerged even after a treatment component was implemented. Most human operant renewal studies have solely examined an extinction component during phase 2 (Allessandri et al., 2015; Conhenour et al., 2018; Kelly et al., 2015). However, Kelley et al. (2018) assessed adding a treatment component. The addition of a treatment component mimics what is more likely to occur in a clinical renewal arrangement. Results provide evidence for the idea that change in context alone is sufficient for renewal of problem behavior to occur, despite having contacted treatment. Renewal of problem behavior, despite being treated in one setting, makes evaluating generalization of treatment strategies necessary. Kelley et al. (2018) addressed this in their study (discussed below) by maintaining some aspects of the treatment context in the test context.

Multiple Context Training

Multiple context training involves either the reinforcement or extinction of behavior across different settings prior to returning to a test context. Gunther, Denniston, and Miller (1999) conducted one of the first studies on multiple context training. These researchers assessed respondent fear conditioning by pairing a white noise with a shock during phase one. Phase two occurred across three different contexts. In all three training contexts the white noise was presented in the absence of any shock. Researchers compared renewal of behavior in rats who received training across three different contexts to renewal of behavior in rats who received training in one single context. Results showed that renewal was significantly lower in the multiple context training group. Similar results have been found more recently in combination with additional training sessions across multiple contexts (Thomas et al., 2009). Similar results were also found by Chelonis et al. (1999) who observed decreased renewal of a taste aversion after multiple context training. Balooch and Neumann (2011) also demonstrated this effect with human fear responses. Researchers arranged for a mild shock to be paired with alternating light cues in an A(BCD)A model of renewal. Self-report of shock expectancy was compared to the self-report of participants in an ABA group. Participants in the A(BCD)A group went through extinction training across three different locations. A renewal of shock expectancy was found in the ABA group during phase three. Renewal of shock expectancy was attenuated for all participants in the multiple context training group. Additionally, in the multiple context training group when the extinction contexts were made to resemble the original test context, expectancy was abolished across all participants (discussed further below). Decreased renewal due to multiple context training has been shown to be effective with operant responses as well. Todd et al. (2012) trained a lever pressing response in either one or two contexts in a renewal model. During phase two, responding extinguished more slowly for rats that were trained in multiple contexts. Additionally, renewal was greater in phase three in rats that received training in multiple contexts. These results suggest greater generalization of operant training responses when training occurs in multiple settings. Podlesnik et al. (2017) suggest that these results apply to problem behavior and appropriate behavior that are learned across contexts.

Shiban et al. (2013) conducted a similar study in which they demonstrated the effect of multiple context exposure on decreased renewal of fear behavior to spiders. Specifically, the study examined virtual reality exposure conducted across contexts. Results were compared to participants who underwent virtual reality exposure in a single context. An in vivo exposure trial was conducted with a real spider both before and after virtual reality exposure trials. Dependent variables included self-report ratings of fear in addition to physiological measures (i.e., heart rate and skin conductance). Results show that self-report fear rating was significantly higher post training in the single context group compared to the multiple context group. Additionally, there was a greater attenuation of renewal in the multiple context group. Most importantly, these attenuating effects were observed during an in vivo behavior avoidance test, which is considered the gold standard for evaluating interventions for phobias. In sum, this study demonstrated that multiple context training can help generalize learning post training in a different context. All participants in the multiple context group demonstrated decreased self-report of fear and physiological indicators of fear during virtual reality training and in vivo tests.

These findings demonstrate the importance of multiple context training as a way to facilitate generalization of learning. Podlesnik et al. (2017) call for additional translational and clinical research to assess the efficacy of multiple context training in clinical applications. This technique could be particularly useful in teaching mask tolerance, as generalization of this skill is required outside the clinic setting. The multiple context training research suggests that training compliance to mask tolerance across settings may result in a continuation of compliance in untrained environments.

To date, no study has assessed a behavior analytic intervention to increase compliance to mask tolerance. The purpose of the current study was to evaluate the effectiveness of a graduated exposure intervention to increase mask compliance. Additionally, in order to promote generalization of compliance, multiple context training was conducted. To keep consistent with the literature, the exposure hierarchy was trained across three different contexts (Balooch & Neuman, 2011; Gunter et al., 1999; Shiban et al., 2013). Specifically, the purposes of Experiment 1 were to 1) evaluate the effectiveness of the exposure hierarchy on mask compliance with a terminal goal of one hour of tolerance; 2) note the effects of multiple context training in promoting generalization of learning to an untrained setting during a community probe; and 3) test for maintenance of mask compliance by conducting one month follow up probes. It should be noted that only post training probes were conducted in Experiment 1. It was not within the participants best interest to conduct community probes prior to treatment in order to limit possible virus exposure, since mask tolerance had not yet been taught. The purposes of Experiment 2 were to 1) Evaluate the effectiveness of the exposure hierarchy with additional participants and; 2) note the effects of multiple context training in promoting generalization of mask tolerance specifically to a physician's office setting during a well check visit. It should be noted that compliance to steps in the well check procedure was not of primary interest. Only mask tolerance during the visit was measured.

Chapter 4
Experiment 1

Method

Participants, Setting, Materials

Three children participated in the current study. Miles, Bennet, and Vivian were 6, 9, and 5-years old, respectively. Miles and Bennet spoke in multiple word sentences, and Vivian communicated using 2-3 word phrases. All participants had a diagnosis of autism spectrum disorder (ASD) and parents reported noncompliance to wearing a mask. None of the participants had previous exposure to a mask wearing intervention.

Sessions took place across a behavior analytic clinic, in home, and in a mock physician's office. Probes were conducted in a community setting. The clinic was located within a children's hospital in central Florida. In the clinic, sessions took place within a 3 x 3 m therapy room or 4.7 m x 3.1 playroom. In the therapy room was a desk, two chairs, and materials needed to run the participants' regular therapy session. All participants' in-home training was conducted via telehealth. Sessions took place either in the participants' living room or kitchen. The mock physician office was 3 x 3 m and contained an exam table but no other medical related stimuli. The community setting varied for each participant. Miles' probe was conducted at a barber shop, Bennet's probe was conducted at his piano teacher's house, and Vivian's probe was conducted at her day care.

Materials used in this study were child sized three-layer disposable facial covering masks with elastic ears (3.7 inches X 5.7 inches). It should be noted that the CDC recommends using cloth masks (CDC, 2020a). However, since the setting of the study was a clinic within a hospital, child size surgical masks were initially provided by the hospital to all children receiving services at the clinic. Total session duration was never more than 1 hr. Sessions were run one to four days per week.

Data Collection

Compliance to steps in the graduated exposure hierarchy (Appendix A) served as the dependent variable for all participants. Compliance was defined as keeping the mask on the face for the entire targeted trial duration. Any removal of the mask, or attempt to remove the mask, was counted as an instance of noncompliance for that trial. Vocal protests, in the form of whining, negative vocalizations, or mands for removal, were also measured across trials. However, if the participant engaged in any of these behaviors, but did not remove the mask, it was recorded but compliance was still scored for that trial. If the participant pulled the mask down below their nose (e.g., to scratch their nose or take a sip of water) then replaced the mask over their nose, or allowed the experimenter to replace the mask over their nose within 5 s, this was not scored as an instance of noncompliance to the step. If the participants removed the mask below the nose for longer than 5 s, an instance of noncompliance was scored. At the end of the study, a social validity survey (Appendix C) was administered to the caregiver with whom in-home training was conducted.

Graduated Exposure Hierarchy and Assessment Probes

The 16-step hierarchy was designed to slowly expose participants to higher durations of wearing a mask, with a terminal goal of 1 hour. Contingent on compliance to a step twice in a row, the participant was exposed to the next step. Embedded in the hierarchy were assessment probes. Assessment probes were conducted every three steps. The purpose of the assessment probe was to determine if each step in the hierarchy needed to be trained, or if steps could be skipped. Assessment probes occurred at different steps depending on the participants performance in the hierarchy. For example, if steps 1-3 were trained, then the assessment probe was conducted after step 3. However, if the participants started treatment on step 4, then steps 4-6 were trained, and an assessment probe was conducted after step 6. This allowed for detection of the steps which needed specific training, and where participants could progress more quickly without training. The hierarchy steps were broken down into increasing durations. The majority of graduated exposure hierarchies used in previous research break down teaching based on successive steps in the procedure. The current hierarchy was dissimilar from previous hierarchies in that it was completely duration based. After reaching 1 min of tolerance, hierarchy steps increased in 5 min increments until the terminal goal of 1 hr was reached.

Interobserver Agreement (IOA) and Treatment Integrity

Across trials, a second independent observer collected total duration IOA during sessions. To calculate interobserver agreement, we divided the shorter duration by the longer duration and multiplied by 100 to obtain a percentage. IOA was collected for 75% of Miles' sessions, 68% of Bennet's sessions, and 85% of Vivian's sessions. Mean IOA was 99.5% for Miles, 100% for Bennet, and 100% for Vivian.

To assess treatment integrity during treatment evaluation sessions, data were collected on 1) whether the experimenter ran a preference assessment prior to beginning the first trial of that day; 2) delivery of the preferred item contingent on compliance to training step; and 3) accuracy of implementation training steps. Treatment integrity data were collected on 60% of Miles' sessions, 68% of

Bennet's sessions, and 85% of Vivian's sessions. Mean treatment integrity across all participants for all sessions was 100%.

Procedure

Treatment Evaluation. We used a multiple baseline across participants design to evaluate the effects of a graduated exposure intervention on mask wearing. The goal was to have each participant tolerate wearing a mask for one hour.

Baseline. During baseline, duration of mask wearing was recorded for each participant. No programmed consequences were delivered for keeping the mask on or taking it off. Each trial began when the experimenter said, "Let's put the mask on." Data were then collected on problem behavior and duration of mask wearing. The trial ended when the participant physically removed the mask from their face. The trial also ended if the participant displayed avoidant behavior, such that the experimenter could not place the mask on the participant's face.

Graduated Exposure Hierarchy (Clinic). Prior to beginning the graduated exposure hierarchy, a preference assessment was conducted with each participant at the start of each session, to determine a preferred item to deliver for compliance to a training step. Specifically, multiple stimulus without replacement (MSWO; DeLeon & Iwata, 1996) preference assessment was conducted with all participants initially. For Vivian, we switched to a free operant preference assessment (Roane et al., 1999) as problem behavior was observed during the MSWO when preferred tangibles were removed.

The initial training step differed across participants based on their baseline data. That is, not all participants started at training step 1 in the graduated exposure hierarchy. Training began on the step above the lowest step of compliance in baseline. For example, if in baseline the participant complied to steps 1, 3, 1, and 1 sequentially, then training began on step 2. This was because experimenters did not want to reinforce a lower approximation of compliance than what the participant could display in baseline. Contingent on compliance to a training step, participants were given access to a preferred item, indicated by the preference assessment, and a break from wearing the mask. If compliance occurred on steps 1-4, a one-minute break was given. If compliance occurred on steps 5-16, a five-minute break was given. If the participant displayed noncompliance to a step, in the form of removing their mask from their face, then the participant was still given a break, but did not receive access to their preferred item. If the participant whined, requested the mask be removed, or engaged in negative vocalizations during the trial, these behaviors were tracked but the experimenter did not remove the mask. The criteria to move to the next training step was two trials in a row with compliance. The criteria to fade back to a previous training step was five trials in a row of noncompliance. After the participant displayed compliance to each step twice, for three consecutive steps, an assessment probe was conducted. The purpose of the assessment probe was to test if each step in the hierarchy needed to be trained, or if the participant could demonstrate quicker progression through the hierarchy without training each step. No programmed consequences were delivered for compliance or noncompliance during the assessment probes. If the participant regressed in the hierarchy during a probe, then compliance training started on the next step. For example, if steps 4-6 were trained and, during the assessment probe, the participant only displayed compliance up to step 2, training began on step 3 again. The participant was required to wear the mask during one hour of their regular clinic schedule. For all participants, this entailed wearing a mask across natural environment training (NET) and intensive teaching trials (ITT). Participants were required to master wearing the mask during their NET sessions first. This was done for two reasons. First, NET usually occurred in the playroom where other children were present. It was more important to teach mask compliance in this setting, compared to a private therapy room. Second, there are generally less demands placed on the participant during NET, and the participant gets to choose their NET activity. Due to decreased demands and increased incorporated choice, this could potentially make this instruction time less aversive than ITT. NET for Bennet and Miles was 20 min, and for Viviane it was 30 min.

Graduated Exposure Hierarchy (In-home). Following mastery of the exposure hierarchy in the clinic, in-home caregiver training sessions were conducted. It should be noted that the purpose of this phase of the study was not to teach mask wearing in-home for the participants, as mask wearing in home is not as critical as mask wearing in the community. The purpose of this phase was to familiarize parents and caregivers with the graduated exposure procedures used to teach mask tolerance, and evaluate compliance when the instruction to wear a mask comes from the caregiver. At the time of the study caregivers were not allowed in the clinic to decrease the amount of human contact in that setting. Therefore, in-home training was conducted. For all participants, training sessions were conducted via telehealth. Miles' and Vivian's caregivers were their mothers, and Bennet's caregiver was his nanny. At the start of the training session, the experimenter described the purpose of the graduated exposure hierarchy to the caregiver. Steps in the hierarchy and probes were reviewed with the parent or caregiver. An initial probe was conducted with the participant in-home to determine compliance to mask wearing before introducing the exposure hierarchy. The instruction, "It's time to wear the mask" always came from the caregiver during this phase. If, during the initial in-home probe the participant displayed compliance to all steps in the training hierarchy, then exposure treatment was discussed and role played with the experimenter, and all questions caregivers asked were answered. If the participant displayed noncompliance during the initial probe, then the experimenter described to the caregiver how to implement each training step. Data were not collected on caregiver behavior. The structure of the in-home session was based on the structure of a clinic session (i.e., less demands while first wearing the mask followed by a period of higher demands). For example, first games were played with the caregiver during the first half of the session then, if the participant tolerated the mask during that time, the caregiver then switched to asking the participant to complete different tasks. Some examples of instructional tasks from caregivers include completing chores around the house, writing letters, or working on school work.

Graduated Exposure Hierarchy (Mock Physician Office). A mock physician office was used as the third training setting. A desk and an exam table were in the office; no other stimuli were inside the office. This setting was chosen as the third training setting for two reasons. The behavior clinic where participants received services was located within a hospital. Researchers had convenient access to this room to run training trials. A second therapy room was not chosen as the third training location because at the time of the experiment;

participants were not allowed to switch therapy rooms in order to decrease contact with multiple individuals across rooms. Second, even though the purpose of the first experiment was not to test for generalization of tolerance to a physician visit, two out of the three participants had primary care visits approaching, and this gave the participants in Experiment 1 practice with tolerance in a similar setting. Sessions were structured similar to the first and second training setting.

Community Probe and Maintenance. Following mastery of the hierarchy across all three settings, a community probe was conducted for each participant. Miles' community probe was conducted in a barber shop, Bennett's community probe was conducted at his piano teacher's residence, and Vivian's community probe was conducted at her day care. The purpose of the community probe was to test generalization of mask tolerance in a setting where training did not occur. Community probes were conducted similar to baseline sessions and assessment probes. There were no programmed consequences delivered contingent on compliance or noncompliance to wearing the mask in that setting. Data on duration of mask wearing were collected as well as frequency data on any problem behavior that occurred while wearing the mask. One month maintenance probes were also conducted with all participants. The maintenance probes were conducted in the clinic setting. Once the participant could demonstrate wearing the mask in clinic for an hour, participants were required to continue wearing the mask across all therapy sessions (for no more than one hour). This was because clinical supervisors and researchers did not want to reinforce escape from mask wearing once they could demonstrate this skill. It was too high-risk of a time to allow participants a break from mask wearing in the clinic until maintenance probes were conducted. During the maintenance probes, participants were asked to put their masks on at the beginning of their session, and data were collected on how long participants kept their masks on. Researchers did not tell participants they could take their mask off after one hour of wear. All participants kept their masks on past the one hour targeted duration.

Results

Figure 1 depicts the results for all participants in Experiment 1. Figure 2 depicts problem behavior for all participants in Experiment 1. For Miles (top tier) baseline compliance ranged from 0 steps to step 3. Miles was the only participant, across Experiments 1 and 2, who displayed physical refusal to the mask during baseline. On baseline sessions 3 through 5, Miles did not allow the experimenter to place the mask on his face. Instead, he engaged in avoidant behavior in the form of turning his body away from the experimenter. Miles began training on step 1 in the clinic. After mastering steps 1 through 3, an assessment probe was conducted.

Miles probed backward in the hierarchy, only demonstrating compliance up to step 2. Following mastery of step 3, Miles displayed problem behavior (in the form of removing his mask) for two trials in a row on step 4. Following this, Miles mastered two trials of steps 4 and 5 in a row. An assessment probe following step 5 indicated that Miles could then tolerate the mask for 60 min in the clinic, skipping 11 steps in the exposure hierarchy. Problem behavior, in the form of whines and mands to remove the mask, ranged from 0 to 4 instances and 0 to 3 instances, respectively. Upon switching settings to in-home training, an initial probe revealed tolerance up to step 7 (15 min and 35 s) before removal of the mask. During this probe he engaged in 1 instance of whining, when the parent placed the mask on his face, and 2 instances of mands for removal. Training was then conducted on steps 8, 9, and 10 to mastery. Following mastery of 3 steps in a row, another assessment probe indicated Miles was able to tolerate the mask a full hour in the home setting. Mask tolerance was then tested in in the mock physician office. Upon an initial probe, Miles demonstrated the ability to tolerate the mask for a full hour without any additional training. He manded three times for the mask to be removed, but did not remove it from his face. A community probe was conducted with Miles and his family at a barber shop. Miles tolerated his mask for a full hour in this setting. A one month follow-up probe in the clinic revealed Miles could still tolerate the mask for one hour in that setting. During the probe, we did not remove the mask once the hour had passed. Instead, we assessed how long Miles kept the mask on without a prompt to remove it. Miles was able to tolerate his mask for five hours (his entire therapy session) without problem behavior in the form of removal.

For Bennet (middle tier), baseline compliance ranged from steps 1 through 3. Bennet began training on step 2 in the clinic. He immediately mastered steps 2-4. Following this, an assessment probe was conducted, and Bennet displayed tolerance of the mask up to step 6 (skipping 2 steps). Training then started on step 7. Bennet mastered tolerance for steps 7-9 in a row without mask removal. An assessment probe then revealed tolerance to all steps in the hierarchy for a one hour duration (skipping 7 training steps). Bennet displayed the lowest levels of problem behavior, in the form of whines and mands to remove his mask, across all participants. Upon switching to in-home training, an initial probe revealed tolerance to all hierarchy steps when his nanny asked him to wear his mask and ran the one hour session. Role play was then conducted with the nanny to practice graduated exposure, with the researcher acting as the participant. Mask tolerance was then tested in the mock physician office. An initial probe revealed Bennet could tolerate the mask for a full hour without any additional training. A community probe was conducted with Bennet at his piano instructor's house. Bennet tolerated his mask for a full hour in this setting. A one month follow-up probe in the clinic revealed Bennet could still tolerate the mask for one hour in that setting. During the probe, we did not remove the mask once the hour had passed. Instead, we assessed how long Bennet kept the mask on without a prompt to remove it. Bennet was able to tolerate his mask for four hours (his entire therapy session) without problem behavior in the form of removal.

For Vivian (bottom tier), baseline compliance ranged from steps four through five. This was the highest tolerance seen in baseline across all participants. Vivian did not whine or ask for the mask to be removed during any baseline session. Tolerance training for Vivian started on step five. Vivian displayed problem behavior, in the form of removal of her mask, for the first four training sessions, despite having the highest mask tolerance in baseline. Researchers hypothesize this was due to a carryover of problem from the MSWO preference assessment run prior to experimental sessions.

During her therapy sessions, Vivian displayed problem behavior when a preferred item was withheld or removed. During a MSWO, after the first item is selected, it is withheld until the individual selects the remaining stimuli, in order to obtain a preference hierarchy. Vivian reliably chose a toy truck first during each MSWO. When the experimenter withheld the MSWO and presented the remaining items, Vivian began to cry and engage in property destruction. It is hypothesized that problem behavior, in the form of mask removal, was due to carryover problem behavior from the MSWO. Based on this hypothesis, we switched her preference assessment format to free operant, where she was allowed continuous access to any preferred item for 5 min. Time spent manipulating each toy was measured, and the toy she engaged with the longest during the assessment served as the preferred item delivered contingent on compliance to a training step. Following this change, Vivian displayed tolerance to two consecutive step 5 trials and one step 6 trial. She then engaged in problem behavior, in the form of mask removal, on step 6 for two consecutive trials. Researchers hypothesized that this may, in part, have been due to withholding access to her preferred item until the trial was over. Next, a visual timer was added to indicate to Vivian when the trial would be over, and she could access her toy. Following this change, she mastered steps 6 and 7. The visual timer was then quickly faded out during the following assessment probe, during which she displayed tolerance up to step 9 (skipping 2 steps). During the assessment probe, Vivian manded 5 times for her mask to be removed. Mands were ignored and Vivian kept the mask on for a duration of 26 min and 47 s. Training then began on step 10, and Vivian tolerated steps 10 through 12 without mask removal. An assessment probe then indicated tolerance for a full one hour period (skipping 4 training steps). Upon switching to in-home training, an initial probe revealed tolerance to all hierarchy steps when her mother asked her to wear her mask, and ran the one hour session. Role play was then conducted with the mother to practice graduated exposure, with the researcher acting as the participant. Mask tolerance was then tested in the mock physician office. An initial probe revealed Vivian could demonstrate the ability to tolerate the mask for a full hour without any additional training. A Community probe was conducted with Vivian at her day care. Vivian tolerated her mask for a full hour in this setting. A one month follow-up probe in the clinic revealed Vivian could still tolerate the mask for one hour in that setting. During the probe, we did not remove the mask once the hour had passed. Instead, we assessed how long Vivian kept the mask on without a prompt to remove it. Vivian was able to tolerate her mask for five hours (her entire therapy session) without problem behavior in the form of removal.

Data from the social validity survey indicated that all caregivers found the graduated exposure procedure to be effective at increasing their child's tolerance to wearing a mask. On a scale of one (not at all) through five (very much), all caregivers indicated it was very important to them that their child wear a mask while in public. When asked how difficult the graduated exposure procedure was to implement, one caregiver rated the procedure a one (easy) and the other caregivers scored a two (relatively easy). All caregivers scored a five to indicate they felt confident their child would be able to wear a mask in other community settings and that they felt confident they could implement the procedure beyond one hour. Additional open ended comments included some of the following; "Within a few weeks of starting graduated exposure my son was able to wear a mask", "When we started this process our child would not tolerate having a mask on his face. He would have problem behavior just from the suggestion to put one on. Now he can wear a mask for long periods of time", and "This was extremely helpful and necessary during the pandemic."

Experiment 1 Discussion

In Experiment 1, we examined the effects of a graduated exposure procedure on increasing mask tolerance across three individuals with autism. We also examined the effects of multiple context training on generalization of mask tolerance to an untrained community setting. All participants were able to tolerate wearing a mask for at least one hour. Data from the maintenance probes indicated that Miles and Vivian could tolerate their mask for a five hour duration, and Bennet could tolerate his mask for a four hour duration. Additionally, results from a community probe indicated that all participants were able to tolerate their masks for an hour duration in an untrained setting. Miles was able to tolerate wearing his mask at a barber shop, Bennet was able to tolerate wearing his mask at his piano instructor's house, and Vivian was able to tolerate wearing her mask for one hour in a day care setting. These results suggest the multiple context training could have led to increased generalization of mask tolerance for all three participants. Generalization of mask tolerance is an important skill to address so individuals can access additional community environments, where tolerance was not specifically trained. These data elaborate on the findings of previous research in a few ways. First, graduated exposure has been shown to be an effective intervention to promote compliance to medical and dental procedures (Altabet et al., 2002; Beck et al., 2005; Hagopian et al., 2001, Reimers et al., 1988). To date, a graduated exposure procedure has never been assessed as a technique to promote compliance to mask tolerance. In fact, the literature indicated no behavior analytic techniques have been assessed to increase mask tolerance. Data from the current study indicate this could be an effective technique to increase this behavior. Second, this study adds to the multiple context training literature, providing further support for the idea that training a behavior targeted for acquisition across different settings may lead to generalization of the skill in an untrained environment. A limitation of Experiment 1 was that there was no community probe conducted prior to intervention. If a community probe was conducted prior to intervention, pre and post-mask tolerance data, in that specific setting, could have been compared in an A(BCD)A format, similar to a typical multiple context training arrangement. This would have given researchers a more accurate measure of generalization of tolerance. Without pre-intervention baseline data on mask tolerance in the community setting, we cannot reliably state whether generalization of learning occurred to the untrained setting. However, as discussed in the method section for Experiment 1, at the time a pre-intervention probe in the community setting would have occurred, researchers and caregivers did not feel it was safe to test mask tolerance in a community setting. Based on caregiver report, experimenters hypothesized that baseline levels of mask tolerance would be low across all participants. We did not want to risk possibly exposing participants to COIVD-19. Therefore, we proceeded with gathering baseline data in a private room in a clinic setting that was sanitized before and after experimental sessions.

The assessment probes built into the hierarchy showed that all participants in Experiment 1 did not need training on each hierarchy step. Miles was able to skip 11 training steps in the clinic setting, 13 training steps in the home setting, and all steps in the third training setting. Bennet was able to skip 9 steps in the clinic setting, and probed out of all training steps in the home and mock physician office setting. Vivian was able to skip 6 steps in the hierarchy in the clinic setting and, similar to Bennet, all steps in the home and mock physician office setting.

Miles was the only participant, across Experiments 1 and 2, who regressed in the hierarchy during the first assessment probe. After training steps 1 through 3, an assessment probe indicated compliance up to step 2. We hypothesize this regression in compliance occurred because a preference assessment was not conducted before the probe. During the assessment probe, no programmed consequence was offered for keeping the mask on, or taking it off. After the first three training sessions, Miles was given an iPad™ (his preferred item, indicated by an MSWO) for keeping his mask on. During the assessment probe, Miles asked "iPad™?" The experimenter ignored the mand and continued with the session. At this point, Miles removed the mask from his face prior to keeping it on for a longer duration than what had been trained (30 s). It is possible that the regression occurred because Miles learned that that he would not receive the iPad™ for keeping the mask on. Miles was also the only participant whose problem behavior, in the form of mask removal, returned when switching to the in-home setting. He tolerated his mask for 15 min and 35 s before removing it. While this was higher than his baseline tolerance, it was lower than his 60 min of mask tolerance in the clinic setting. This could be due to Miles' generally low compliance with his mother's instructions. Parent training for Miles and mom is usually based on increasing Miles' compliance to mom's instructions. It is possible that there was a return of problem behavior because mom issued the instruction to put on the mask. However, after mom ran the graduated exposure procedure, Miles was then able to master tolerance training for steps 8 through 10 consecutively, and probed up to 60 min of tolerance.

Vivian demonstrated the highest frequency of mask removal across all participants in both experiments. On her first four training sessions, Vivian displayed mask removal. As discussed above, this may have been due to carryover problem behavior from the MSWO preference assessment that was conducted before sessions. In an MSWO format, preferred toys are placed out in front of the participant. The participant is allowed to pick a toy, manipulate it for a brief time, and is then required to relinquish the toy in order to select again. When selecting again, the highest preferred item is not placed in the array, in order to yield a preference hierarchy. However, it can sometimes be difficult for individuals to relinquish their highest preferred item and choose another toy. Vivian reliably chose a toy truck first in every preference assessment. When the experimenter withheld the truck and instructed her to pick another toy, Vivian began to cry and throw the other toys.

It is not uncommon for this preference assessment format to evoke problem behavior. Kang et al. (2010) showed that individuals who display problem behavior maintained by access to tangibles are more likely to engage in problem behavior during MSWO and paired stimulus preference assessments. Kang et al. evaluated this with two children with developmental disabilities. Functional analyses indicated their problem behavior was maintained by access to tangibles. Problem behavior during a paired stimulus, MSWO, and free operant preference assessment was compared. Results indicated that both participants displayed higher problem behavior in the MSWO and paired stimulus format, but not in the free operant format. Based on this study, the preference assessment conducted prior to experimental sessions was switched to a free operant format for Vivian. Vivian then displayed mask tolerance for the next three training sessions. It is hypothesized that mask removal was due to carryover of problem behavior from the MSWO conducted in the beginning of the session. Then, for two consecutive trials on step 6, Vivian removed her mask. We hypothesized that this also may, in part, have been due to withholding access to her preferred item until the trial was over. We spoke to Vivian's therapy team, who indicated they frequently use visual timers to show her when preferred items will be available. Based on this information, a visual timer was added to signal to Vivian when the trial would be over, and she can access her toy. This seemed to be effective at promoting mask tolerance, as compliance occurred on the following four training steps.

Chapter 5
Experiment 2

Method

Participants, Setting, and Materials

Three different children participated in Experiment 2. Patrick, Chris, and Cameron were 8, 6, and 4-years old, respectively. Patrick spoke in multiple word sentences. Chris and Cameron, brothers, communicated using 2-3 word phrases. All participants had a diagnosis of autism spectrum disorder (ASD) and parent reported noncompliance to wearing a mask. Patrick had no previous exposure to practicing mask tolerance. Chris and Cameron’s mother reported attempting to practice in-home with them, but she was unsuccessful at getting them to put their masks on. All parents reported delays in scheduling physician office visits because their children could not tolerate wearing masks.

Sessions were conducted in the same setting as Experiment 1 (therapy room in a clinic, in-home, and mock physician office). In this experiment, pre and post intervention probes were conducted in a hospital waiting room, and physician office. Chairs and one television screen were in the hospital waiting room. An exam table, computer, and medical stimuli were in the physician’s office. Materials used in the study were the same materials used in Experiment 1.

Data Collection

Compliance to steps in the graduated exposure hierarchy also served as the primary dependent variable for Experiment 2. An additional hierarchy (Appendix B) was created for steps in the physician visit (a 7-step hierarchy). Compliance to the specific steps in this hierarchy was not measured. The variable of interest was mask tolerance during these steps. For example, we were not measuring whether the participant could tolerate an otoscope ear exam, but whether the participant kept the mask on during an otoscope ear exam. If the participant engaged in problem behavior, in the form of whining or crying, but kept the mask on, then compliance was scored for that step. If at any point the participant removed the mask, an instance of noncompliance was scored for that step. Additional pre and post-intervention data were collected on mask tolerance in a waiting room setting. The goal of mask tolerance in this setting was 30 min. This goal was determined after interviewing multiple primary care pediatricians on average waiting times. Compliance and problem behavior were defined the same way across these settings. Again, the purpose of Experiment 2 was to determine whether mask tolerance training across settings could lead to generalization of compliance during a physician visit.

Pre-Intervention Probes

Pre-Intervention probes were conducted with each participant in a waiting room and physician's office. During the waiting room probe, the participant and experimenter sat in a waiting room at a hospital and the experimenter instructed the participant "It's time to put your mask on." Total duration of mask tolerance was then recorded. The participant was given a preferred item to interact with while in the waiting room. The probe ended when the participant physically removed the mask from their face.

A pre-intervention probe was also conducted in the physician office setting. A novel individual acted as the physician. The participant was taken back to the physician's office by the experimenter and sat on the exam table. The experiment then told the participant "It's time to wear the mask." Data were then collected on how many well-check steps the participant could tolerate while wearing the mask. If the participant engaged in problem behavior, in the form of whining or crying, they were instructed to continue to proceed through the hierarchy. If the participant engaged in problem behavior, in the form of mask removal, they were instructed to stop.

Graduated Exposure Hierarchy and Assessment Probes

The graduated exposure hierarchy was conducted in an identical manner to Experiment 1 across all three settings (therapy room in clinic, in-home, and mock physician office).

Interobserver Agreement (IOA) and Treatment Integrity

Across trials, a second independent observer collected total duration IOA during sessions. To calculate interobserver agreement, we divided the shorter duration by the longer duration and multiplied by 100 to obtain a percentage. IOA was collected for 65% of Patrick’s sessions, 76% of Chris’s sessions, and 76% of Cameron’s sessions. Mean IOA was 100% for Patrick, 100% for Chris, and 99.6% for Cameron.

To assess treatment integrity during treatment evaluation sessions, data were collected on whether the experimenter ran a preference assessment prior to beginning the first trial of that day, delivery of the preferred item contingent on compliance to the training step, and accuracy of implementation training steps. Treatment integrity data were collected on 65% of Patrick’s sessions, 76% of Chris’s sessions, and 76% of Cameron’s sessions. Mean treatment integrity was 100% for Patrick, 99.7% for Chris, and 99.3% for Cameron

Post-Intervention Probes

Following training across all three contexts, post-intervention probes were conducted in the waiting room and physician office settings. Probes were conducted in the same manner as they were prior to intervention.

Results

Figure 3 depicts the results for all participants in Experiment 2. Figure 4 depicts problem behavior data for all participants in Experiment 2. Patrick (top tier) tolerated the mask for 12 min and 3 s in the waiting room (corresponding to step 6 in the duration-based exposure hierarchy). Patrick's probe in the physician's office revealed tolerance up to step 2 during the well check procedures. Baseline tolerance in the clinic never passed step 4 in the exposure hierarchy. Patrick began training on step 5 in the clinic. Steps 5 through 7 were mastered consecutively, and an assessment probe was conducted. The assessment probe revealed compliance up to step 11 in the hierarchy (skipping 4 steps). Steps 12 through 14 were then trained; no problem behavior in the form of mask removal occurred during these steps. Even though mask removal did not occur, Patrick did engage in other problem behavior during these steps. As mentioned above, participants were required to tolerate wearing the mask during their NET sessions first, then during their ITT sessions. Patrick frequently engages in high levels of problem behavior during his ITT sessions. On session 20, Patrick's first ITT session while wearing the mask, he displayed 20 instances of mands to remove the mask, and 7 instances of whining. Mands and whines were ignored and ITT continued as usual. Following this, there was a decreasing trend in mands and whines across Patrick's tolerance training until there were zero instances of both in the clinic. An assessment probe then revealed tolerance for the full hour (skipping 2 steps). Upon switching to in-home training, an initial probe revealed tolerance to all hierarchy steps when his mother asked him to wear his mask and ran the one hour session. Role play was then conducted with his mother to practice graduated exposure, with the researcher acting as the participant. Mask tolerance was then tested in the mock physician's office. An initial probe revealed Patrick could demonstrate the ability to tolerate the mask for a full hour without any additional training. During the post-intervention probes, Patrick displayed tolerance of the mask for 30 min in the waiting room, and for all 7 steps in the well check visit.

Chris (middle tier) tolerated the mask for 3 s in the waiting room (corresponding to step 2 in the duration based exposure hierarchy). Chris' probe in the physician's office revealed tolerance of the mask to zero steps during the well check procedures. Baseline tolerance in the clinic ranged from steps 2 through 3. Chris began training on step 3 in the clinic. Steps 3 through 5 were mastered consecutively, and an assessment probe was conducted. The assessment probe revealed compliance up to step 16 in the hierarchy (skipping 11 steps). Chris probed out of the most training steps in the clinic out of all participants across Experiments 1 and 2. Chris also displayed very low problem behavior, whines or mands to remove the mask, in the clinic. During the last assessment probe, Chris did take the experimenter's hands and bring them to the ear loops of the mask around his face. Since Chris had very limited vocal language, we counted this as a mand to remove the mask. Upon switching to in-home training, an initial probe revealed tolerance to all hierarchy steps when his mother asked him to wear his mask and ran the one hour session. Role play was then conducted with his mother to practice graduated exposure, with the researcher acting as the participant. Mask tolerance was then tested in the mock physician office. An initial probe revealed Chris could demonstrate the ability to tolerate the mask for a full hour without any additional training. During the post-intervention probes, Patrick displayed tolerance of the mask for 30 min in the waiting room, and for all 7 steps in the well check visit. During the well check visit, Chris engaged in 10 instances of whining when the mask was on; this was the highest levels of problem behavior seen across all sessions. Chris historically had a difficult time tolerating well check visits and, based on parent report and experimenter observation, would frequently whine and cry during the visit. Even though Chris did engage in this behavior, he did not remove the mask during the visit.

Cameron (bottom tier) tolerated the mask for 36 s in the waiting room (corresponding to step 3 in the duration-based exposure hierarchy). Cameron's probe in the physician's office revealed tolerance of the mask to zero steps during the well check procedures. Baseline tolerance in the clinic ranged from steps 3 through 4. Even though no attention was provided for mask removal, Cameron would frequently say "Take off?", then take his mask off and smile at the experimenter. Cameron began training on step 3 in the clinic. Steps 3 and 4 were mastered, then Cameron displayed problem behavior, in the form of mask removal, on the first trial of step 5 (5 min). He then demonstrated tolerance to step 5 on the second trial, then noncompliance on the third trial of step 5. Cameron then displayed tolerance to step 5 twice consecutively, and an assessment probe was conducted. Cameron did not probe up or down during the assessment probe (5 min and 22 s of mask tolerance). Training then began on step 6, and Cameron displayed compliance to steps 6 through 8 consecutively. An assessment probe revealed tolerance of all steps in the hierarchy. Upon switching to in-home training, an initial probe revealed tolerance to all hierarchy steps when his mother asked him to wear his mask and ran the one hour session. Even though Cameron never removed his mask, he did engage in 5 instances of whining during the one hour session. Role play was then conducted with his mother to practice graduated exposure, with the researcher acting as the participant. Mask tolerance was then tested in the mock physician's office. An initial probe revealed Cameron could demonstrate the ability to tolerate the mask for a full hour without any additional training. During the post-intervention probes, Cameron displayed tolerance of the mask for 30 min in the waiting room, and for all 7 steps in the well check visit.

Data from the social validity survey indicated that all caregivers found the graduated exposure procedure to be effective at increasing their child's tolerance to wearing a mask. On a scale of one (not at all) through five (very much), all caregivers indicated it was important to them that their child wear a mask while in public. When asked how difficult the graduated exposure procedure was to implement, all caregivers scored a one (easy). All caregivers scored a five to indicate they felt confident their child would be able to wear a mask in other community settings and that they felt confident they could implement the procedure beyond one hour. Additional open ended comments included some of the following; "I am thrilled that this research took place", "Our son is now able to keep a mask on his face for over an hour", and "I now feel comfortable taking my sons to the doctors because I know they will be able to keep their masks on."

Experiment 2 Discussion

As in Experiment 1, all participants were able to tolerate the mask for at least one hour after treatment. Data from the post intervention probes indicate all participants were able to tolerate wearing the mask for 30 min in a waiting room, and for all 7 steps in the physician's office hierarchy. The data from the current study add to the literature by providing further evidence of the graduated exposure intervention as an effective technique to increase mask tolerance. Additionally, they demonstrate that multiple context training may be an effective method to promote generalization to an untrained setting. Pre-intervention probe data indicated low mask tolerance in the waiting room and physician's office setting. After training tolerance across three environments, participants were able to tolerate the mask in the untrained settings. It should be noted that, at no point during training across the three environments were steps in the well-check practiced. The participants did not have a history of noncompliance to tolerating well-check visits, but rather, demonstrated noncompliance to tolerating a mask in those settings. The primary purpose of Experiment 2 was to assess generalization of mask tolerance to those specific settings. This is why the procedure was not stopped if the participant demonstrated any other form of problem behavior, but only stopped if the participant displayed mask removal.

Also similar to Experiment 1, the assessment probes built into the hierarchy showed that all participants did not need training on each hierarchy step. Patrick was able to skip 6 training steps in the clinic setting, 16 training steps in the home setting, and all steps in the mock office. Chris was able to skip 11 steps in the clinic setting, and probed out of all training steps in the home and mock physician's office setting. Cameron was able to skip 8 steps in the hierarchy in the clinic setting and, similar to Patrick and Chris, all steps in the home and mock physician's office setting.

Across all participants, Patrick displayed the highest instances of manding for the mask to be removed. On session 12, Patrick asked for the mask to be removed 12 times. Session 12 was also Patrick's first ITT session while wearing the mask. Patrick had a history of increased problem behavior during his ITT sessions. It is hypothesized that the increase in mands for removal and whines could be a due to a combination of wearing the mask, and increased demands during his ITT session. All mands to remove and whines were ignored. Patrick's data indicate a decreasing trend in these problem behavior over sessions. By session 18 (after 7 more ITT sessions wearing the mask), Patrick was no longer manding for it to be removed.

Chris skipped the most steps in the tolerance hierarchy across participants from Experiment 1 and Experiment 2. Initially, steps 3 through 5 were trained, then an assessment probe indicated Chris skipped 11 steps in the hierarchy. He did not display any return of mask renewal across the training settings. Chris' highest instances of problem behavior occurred during his post-intervention well-check. While mask removal did not occur, Chris did whine 10 times during the well-check. All whines occurred when the mock physician checked Chris' ears. Chris had a history of engaging in problem behavior when his ears were checked. While his whining did increase, Chris did not take the mask off of his face during the visit.

As mentioned above, during Cameron's baseline, he would take his mask off then smile at the experimenter. Even though at no point during the experiment was attention provided for mask removal, Cameron reliably smiled upon each instance of mask removal. This same behavior also occurred during instances of removal in treatment sessions. Cameron had a history of problem behavior maintained by access to attention. A large focus of Cameron's behavior therapy sessions focused on teaching him to ask for attention appropriately, especially with caregivers. His mother mentioned that she did try to increase mask compliance at home prior to starting the intervention, but was unsuccessful. It is possible that, while working with his mother, attention was provided to Cameron for removing his mask. It is hypothesized that Cameron's mask removal may have functioned to access attention. Based on this hypothesis, the experimenter began providing noncontingent attention for keeping his mask on (e.g., "Good job wearing your mask so nicely Cameron!"). Following this change, no further instances of mask removal were observed. Cameron's regular parent training sessions typically focused on increasing compliance to caregiver instruction. It was hypothesized that Cameron would display a return of mask removal upon switching to the in-home setting. However, Cameron did not remove his mask when his mother asked him to wear it. He did ask for it to be removed 5 times, but his mother was instructed to ignore this request, and she redirected him back to the activity they were working on. Additionally, mask removal may not have occurred as mom was instructed to provide him with attention for keeping his mask on.

A limitation of Experiment 2 was that the pre and post-intervention probes were not conducted by a licensed physician, but rather, an individual who was novel to the participant and trained on the procedures of the study. The probe tolerance data may have been more accurate if conducted by a physician. At the beginning of the study, Patrick's caregiver mentioned a reluctance to schedule a doctor's appointment, due to Patrick's limited ability to tolerate the mask. After completing the hierarchy and post-intervention probes, Patrick's caregiver did schedule an appointment. His mother reported that he kept his mask on the entire time they were in the waiting room, and while the physician conducted the checkup.

Chapter 6
General Discussion

In two experiments, we examined the effect of a graduated exposure hierarchy on mask tolerance among 6 children with ASD. In Experiment 1, we evaluated a graduated exposure hierarchy to increase mask compliance across three participants diagnosed with autism. We also evaluated multiple context training to observe generalization of mask tolerance in an untrained setting. All three participants displayed mask tolerance up to a one hour duration across all three settings. Also, all participants were able to skip multiple training steps in the exposure hierarchy, suggesting not every step needed to be trained. Additionally, all participants displayed mask tolerance for one hour in an untrained community setting. Miles displayed tolerance at a barber, Bennet displayed tolerance at his piano teacher’s house, and Vivian displayed tolerance at her day care.

In Experiment 2, we evaluated the efficacy of the same graduated exposure hierarchy with three additional participants. We also evaluated a multiple context training procedure to observe generalization of mask tolerance specifically to a physician’s office setting. Pre and post-treatment probes were conducted in a hospital waiting room and physician office. As mentioned above, tolerance to medical procedures was not the aim of Experiment 2. Rather, the goal was tolerance to the mask while the routine exam was conducted. Therefore, the visit was only stopped if the participant removed their mask at any point while in the waiting room or physician's office. The visit was continued if the participant engaged in other problem behavior (e.g., whining, negative vocalizations, mands to remove the mas) as long as they kept their masks on. All participants displayed tolerance for one hour across all three settings. Additionally, all three participants displayed increased tolerance while in the hospital waiting room and physician office.

Overall, the graduated exposure procedure was effective at increasing mask tolerance across all participants beyond the one hour goal. In Experiment 1, multiple context training may have led to generalization of mask tolerance to untrained contexts for all three participants. In Experiment 2, the multiple context training may have led to tolerance specifically in the physician's office setting.

There are a few reasons why individuals may display an initial lack of mask tolerance. First, the participants may have displayed mask removal, and in Miles' case overt mask refusal, because the mask was an aversive stimulus. The mask may have been unfamiliar and unpleasant to wear. Problem behavior, in the form of removal or refusal, resulted in early termination or avoidance of mask wearing. In this case, the problem behavior was negatively reinforced as it removed the aversive event. Some of the participants did not have a history of mask exposure prior to the beginning of the study. However, it is possible that these participants may have a history of engaging in similar problem behavior to avoid other similarly aversive events. Mask wearing, comparable to the medical tolerance literature, can lead to escape and avoidant behavior even when the event itself is not a threat in any biological sense. A compounding problem here is that individuals with ASD exhibit higher rates of avoidance and noncompliance to basic medical procedures, compared to typically developing children (Allen & Kupzyk, 2016). In their review, Allen & Kupzyk discuss compliance problems during common procedures, due to intense and unfamiliar sensory experiences. Wearing an object that covers the mouth and nose, and is attached by ear loops, may be an unfamiliar and intense sensory experience for some. Given this, the fact that participants engaged in avoidant behaviors in baseline may have been predictable.

As discussed in the introduction, graduated exposure is the most commonly used intervention to decrease these escape and avoidant behaviors in the medical tolerance literature. It is commonly used in combination with either reinforcement, extinction, or both. Graduated exposure arranges for stimuli that elicit escape/avoidant behavior to be repeatedly presented, typically while altering the salience of the stimuli presentation. For example, distance or size of the stimuli presented may be altered. To date, only one other study has created an exposure hierarchy based on time exposed to the stimulus (Reimers et al., 1988). Reimers et al. slowly increased the amount of time the participant was required to wear a nebulizer mask, to a terminal goal of 20 min. However, specifics on how they increased exposure were not provided. The current study offers a structured guideline on a duration-based exposure hierarchy, and a longer terminal goal of mask wearing. Additionally, Reimers et al. implemented escape extinction (holding the participants head in place), while the current study combined only reinforcement-based techniques with the hierarchy.

Another reason individuals may not initially comply with wearing a mask could be a lack of understanding of the importance for doing so. It takes advanced language skills to be able to understand why masks should be worn. The verbal behavior literature has provided some insight on a behavioral process for "understanding" (Parrot, 1984; Schoneberger, 1990; Schoneberger, 1991; Skinner, 1957). One explanation of understanding was provided by Skinner (1957) and termed "understanding-as-knowing" (Schoneberger, 1990). In this explanation, a listener can understand something if they know about the variables controlling a speakers behavior. For example, a listener understands the statement "you need to wear your mask" if they know about all the variables controlling mask wearing behavior. Additionally, the listener should be familiar enough with the conditions of mask wearing that they could make the same statement under the same conditions. The population of participants in the current study may have difficulty understanding all the underlying contingencies regarding the importance of wearing a mask. It is possible that individuals may be more likely to comply with mask wearing if they understand the reasons for doing so. Future research could look into teaching this with individuals who have better language skills. It may be that once these contingencies are understood, compliance with mask wearing might increase.

Based on participant observation, there are some additional parameters of mask tolerance that future research should address. First, while all participants were able to display tolerance, in the form of keeping the mask on their faces, three out of the six participants frequently fidgeted with their masks. Common topographies of this behavior included putting fingers on the outside of the masks, pinching the mask over their noses, and pushing the masks into their mouths. While these were not counted as instances of problem behavior, as the mask stayed positioned over the noses and beneath their chins, it may be important to target this behavior for decrease. The main purpose of wearing the mask is to help prevent the spread of germs. Placing fingers near the mask area may defeat this purpose. When these behaviors occurred during sessions, they were ignored and the participant was redirected back to the activity. Future research may want to measure this behavior specifically, and implement an intervention to target mask touching for decrease.

Future research may also consider conducting pairing sessions prior to beginning mask tolerance. Pairing is a procedure in which one stimulus is delivered simultaneously, or temporally adjacent to a reinforcing stimulus (Esch et al., 2009). Research indicates that pairing a high preference stimulus with a lower preference stimulus may increase the value of the lower preference stimulus over time. This is commonly done between an instructor and child prior to an instructional session. The instructor engages with preferred items with the child for a few minutes prior to delivering instructions. Research has shown that presession pairing can decrease escape and attention maintained problem behavior during instructional time (Kelly et al., 2015; McComas et al., 2003). Pairing a less preferred stimulus with a highly preferred stimulus has also been shown to be effective to decrease food selectivity (Bayens et al., 1990; Piazza et al., 2002) and increase preferences for some tangible items (Hanley et al., 2003). It is possible that by pairing the mask with a preferred item for a certain duration of time, prior to going into a NET or ITT session, mask removal may decrease. For example, if a child's highest preference tangible item is an iPad™, clinicians could consider letting the child play with the iPad™ while wearing the mask, prior to implementing any demands while wearing the mask.

Future research may also consider targeting compliance to different types of masks. In the current study, child size surgical masks were used across experimental sessions for 5 out of the 6 participants. This was because these masks were supplied from the hospital to the children in the clinic. However, not everyone has access to these resources. For Patrick, a surgical mask was used in sessions 1 through 7 then, based on caregiver preference, he switched to a cloth mask in session 8. Although Patrick did not display any problem behavior when the type of mask was switched, it is important to measure mask tolerance across different types of masks (i.e., surgical and cloth) as tolerance may differ depending on the material. After completion of the study, caregivers were informed they could send their child to the clinic wearing a cloth mask. Four out of the six participants switched to cloth mask post-completion of the study. Data were not formally collected on mask tolerance of cloth masks for these participants, but observation of the participants indicated that no additional tolerance training was needed for wearing a cloth mask. However, this may not be the case for all participants. Future research could look at mask tolerance upon switching mask types, in addition to participant preference for a particular type of mask. The four participants who switched to cloth masks were informally asked which masks they preferred to wear. All four participants chose the cloth mask over the surgical mask. This could be an important factor to consider at the beginning of tolerance training. If the individual prefers the cloth mask, using it may expedite the process of tolerance training.

Future research could also look at mask tolerance across different environments. The current study measured mask tolerance in a behavioral clinic, in-home, in a mock physician's office (Experiments 1 and 2), barber shop, day care, piano practice (Experiment 1), hospital waiting room and physician's office (Experiment 2). There are a multitude of other environments in which generalization of mask tolerance could be tested (e.g., grocery stores, amusement parks, or in school). All participants demonstrated generalization of tolerance to different settings, but it is possible that some individuals may not be able to display tolerance in these settings. Future research could be conducted to test for generalization across other settings with other participants. Additionally, mask tolerance in other typically aversive settings should be examined. In the current study, generalization of tolerance was tested specifically to a physician's office. This environment may already be less preferred, and individuals may be more likely to display problem behavior in this environment. It is important to assess whether tolerance can continue to occur in a setting that may be more likely to evoke other problem behavior.

Future research could also look at targeting longer durations of mask tolerance. The terminal goal of the graduated exposure hierarchy of the current study was one hour. It is possible that individuals may be exposed to settings where they will have to display tolerance for longer durations. While the current study did not specifically train tolerance beyond one hour, maintenance probes for the participants showed that they could tolerate the mask for 3 to 5 hour durations. On the other hand, it is possible that longer durations of mask tolerance may be displayed, upon receiving shorter durations of training. During the first three training settings, the participant's were told they could remove the mask after one hour. It is possible that participants may have been able to display longer mask tolerance earlier in the study. Additionally, assessment probes were capped at one hour. Future researchers could run longer assessment probes to note if longer compliance is possible. For example, Chris mastered steps 3 through five in the hierarchy (30 s to 5 min), then was able to display tolerance for a full hour. Similarly, Miles, after mastering step 5, was also able to display tolerance for one hour in the clinic. Bennet, after mastering step 9 (25 min) was able to display tolerance for one hour. It is possible that these participants could have displayed tolerance for longer durations following this training, but this was not assessed. Future research should examine conducting longer assessment probes sooner in the hierarchy.

Most participants engaged in mask removal during the initial training steps in the exposure hierarchy. However, most participants (5 out of 6) were able to skip the last 7 or more training steps in the hierarchy. These data suggest that the hierarchy could be completed more quickly. After mastering mask tolerance for 25 min in the clinic, all participants except one could display tolerance for one hour. Future research should also examine altering the graduated exposure hierarchy to reflect this. For example, researchers could conduct additional probes earlier in the hierarchy, or change the duration increment of the training step. In the current hierarchy, increments increased by 5 min durations until reaching one hour. It is possible that increments could be greater, maybe 10 min or more, with shorter increments for individuals who display difficulty progressing through the hierarchy.

As participants began to wear their masks longer throughout the day, it became increasingly apparent that other skills would have to be trained while the participant wore their mask. For example, drinking water, blowing their nose, and applying Chapstick needed to be trained. These were skills that participants did not know how to navigate while wearing their mask. While the experimenter worked with the participants to be able to still engage in these behaviors while wearing their masks, no formal data were collected on how many of these behaviors needed to be retrained, or the best approach for training them. Training sessions for these behaviors occurred outside of experimental sessions. Future research should also consider best practices for teaching individuals how to engage in these behaviors while wearing a mask.

Additionally, as mask tolerance increased in duration across participants, it also became apparent that a functional communication response (FCR) for mask removal may be necessary to teach. A FCR is used as the alternative response in functional communication training (FCT). FCT is a differential reinforcement procedure in which an alternative is taught, that results is the same reinforcement class which maintains the problem behavior (Tiger et al., 2008). A FCR was not trained in the beginning of the study because researchers did not want to reinforce escape behavior prior to completing the targeted trial duration. Although, as mentioned in the method, the participant was allowed breaks after reaching each targeted trial duration. Additionally, escape extinction was not implemented. Therefore, the participant could technically remove their mask at any point in the session and a break was provided (without access to their indicated preferred item). However, it is reasonable to expect that individuals need a break from wearing their mask, as duration of wear increases. A next step would be teaching how to appropriately ask for a break from the mask. One approach to this could be implementing a multiple schedule a reinforcement. A multiple schedule of reinforcement is a compound schedule of reinforcement in which a discriminative stimulus is correlated with the presence or absence of each element schedule, and reinforcement is delivered for the response requirements in each schedule (Cooper et al., 2007). This way participants have a clear signal to indicate when they are required to keep the mask on, versus a signal to indicate they can remove the mask. Future research should look in evaluating this technique once tolerance is taught.

An instance of noncompliance was scored if the participant pulled their mask below their nose, above their mouth, or completely off their face, for a duration of 5 s or longer. If the participant fixed their own mask within the 5 s timeframe, or allowed the experimenter to fix their mask, then an instance of noncompliance was counted, and the session proceeded. Future research might consider using a vocal prompt to the participant to correct the mask as well. The current study did not allow vocal prompts for mask replacement. However, this is likely more similar to what would occur in many settings with a parent or teacher.

Additional research on mask tolerance should also assess what interventions may increase efficacy of the exposure hierarchy when combined. In the current study, a visual timer was used for one participant and noncontingent attention for appropriate mask wearing was implemented for another participant. It is possible that additional interventions may increase mask tolerance for others outside the current study. For example, video modeling of mask wearing may prove to be an effective method to increase tolerance. Mask tolerance training is an underexamined area of research. Future studies should assess additional interventions to promote tolerance.

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Appendix A
Mask Tolerance Graduated Exposure Hierarchy

Step #	Trial 1	Trial 2	Trial 3	Trial 4	Trial 5	Trial 6	Trial 7	Trial 8	Trial 9	Trial 10
1. Tolerates researcher/parent putting on mask (or puts on own mask)										
2. Wears mask for 10 s										
3. Wears mask for 30 s										
PROBE										
4. Wears mask for 1 min										
5. Wears mask for 5 min										
6. Wears mask for 10 min										
PROBE										
7. Wears mask for 15 min										
8. Wears mask for 20 min										
9. Wears mask for 25 min										
PROBE										
10. Wears mask for 30 min										
11. Wears mask for 35 min										
12. Wears mask for 40 min										
PROBE										
13. Wears mask for 45 min										
14. Wears mask for 50 min										
15. Wears mask for 55min										
Probe										
16. Wears mask for 1 hour										

Appendix B
Mask Tolerance TA- Physician Visit

+ = kept mask on

-= mask removal on that step

* okay to proceed through hierarchy if problem behavior occurs during checkup, as long as participant does not remove the mask. Stop progressing through hierarchy when mask removal occurs

Step #	Probe Data
1. Tolerates wearing mask while sitting on exam table 2 minutes with preferred item	
2. Tolerates wearing mask while doctor looks in R ear 5 s	
3. Tolerates wearing mask while doctor look in L ear 5 s	
4. Tolerates wearing mask during eye check (follows light back and forth 4 times)	
5. Tolerates wearing mask during throat check (allows mask to be pulled down + 5 s check + replacement of mask)	
6. Tolerates wearing mask during chest exam (3 deep breaths on front)	
7. Tolerates wearing mask during chest exam (3 deep breaths on back)	

Neg vocs:___________

Whines:____________

Mands to remove:_____________

Physical Refusal:______________

Appendix C
Social Validity Survey

Child Name:________________________

Caregiver Name: ____________________

Relation to Child:___________________

Date:______________________________

1. The purpose and procedures of graduated exposure have been explained to me?

1	2	3	4	5
____	____	____	____	____
Not at all		Neutral		Very much so

2. How effective do you believe the graduated exposure procedure was at increasing compliance to mask wearing?

1	2	3	4	5
____	____	____	____	____
Not at all		Neutral		Very much so

3. How important is it to you that your child wear a mask while in public places?

1	2	3	4	5
____	____	____	____	____
Not at all		Neutral		Very much so

4. How difficult were the graduated exposure procedures to implement?

1	2	3	4	5
____	____	____	____	____

Not at all		Neutral		Very much so

5. The researchers guidance and feedback, during virtual training, was helpful while implementing the graduated exposure procedure?

1	2	3	4	5
___	___	___	___	___
Not at all		Neutral		Very much so

6. I feel confident that my child will be able to wear a mask when taken to doctor's office for the whole duration of the visit?

1	2	3	4	5
___	___	___	___	___
Not at all		Neutral		Very much so

7. I feel confident that my child will be able to wear a mask out in other community settings?

1	2	3	4	5
___	___	___	___	___
Not at all		Neutral		Very much so

8. Based on the virtual training, I feel confident I could implement a graduated exposure procedure to increase the amount of time my child wears a mask (beyond one hour)?

1	2	3	4	5
___	___	___	___	___
Not at all		Neutral		Very much so

9. Overall, I feel the graduated exposure procedure was beneficial in terms of helping my child be able to wear a mask for a long duration of time?

1	2	3	4	5
____	____	____	____	____
Not at all		Neutral		Very much so

Additional Comments:

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Figure 1

Figure 1. *Step number completed across all settings for Miles, Bennet, and Vivian in Experiment 1. Open data points depict sessions in which mask removal occurred. Closed data points depict session in which mask removal did not occur. Circles depict training sessions, squares depict assessment probes, and triangles depict community probes.*

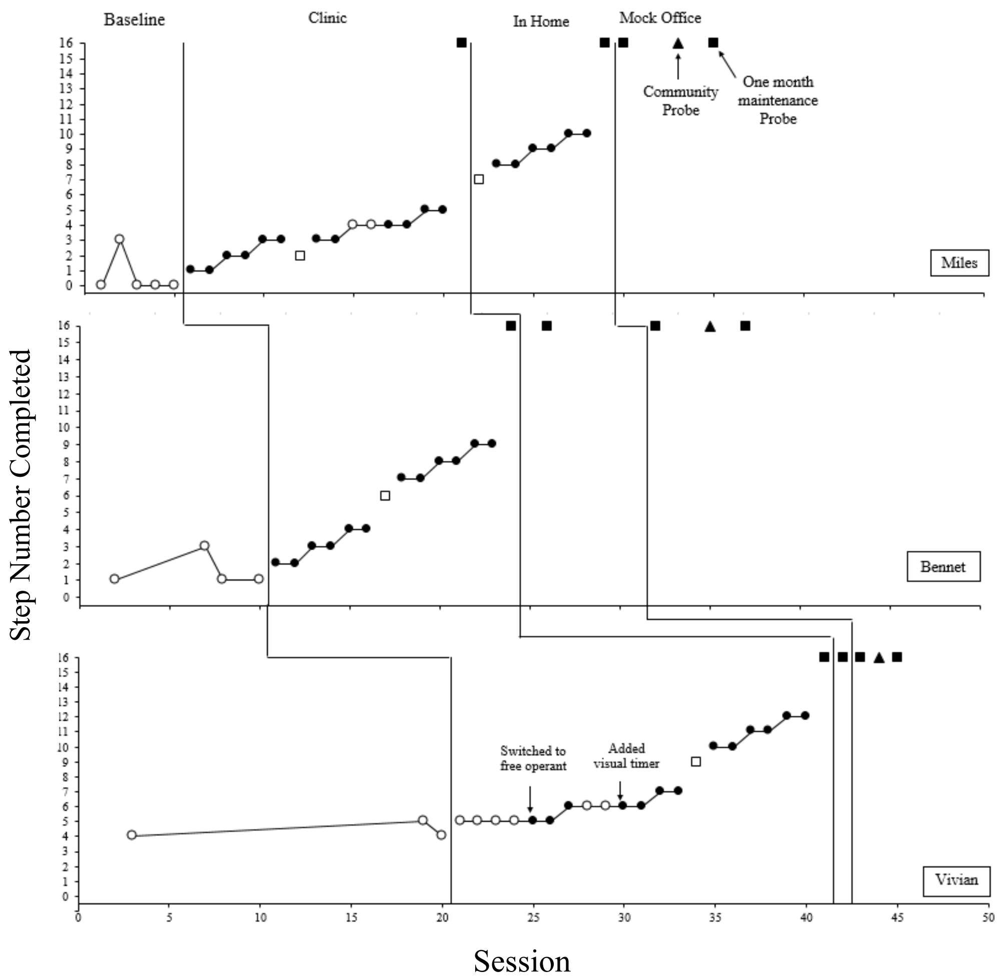

Figure 2

Figure 2. *Frequency of problem behavior of across settings for Miles, Bennet, and Viviane in Experiment 1. Closed circles depict mands to remove the mask and open triangles depict whines.*

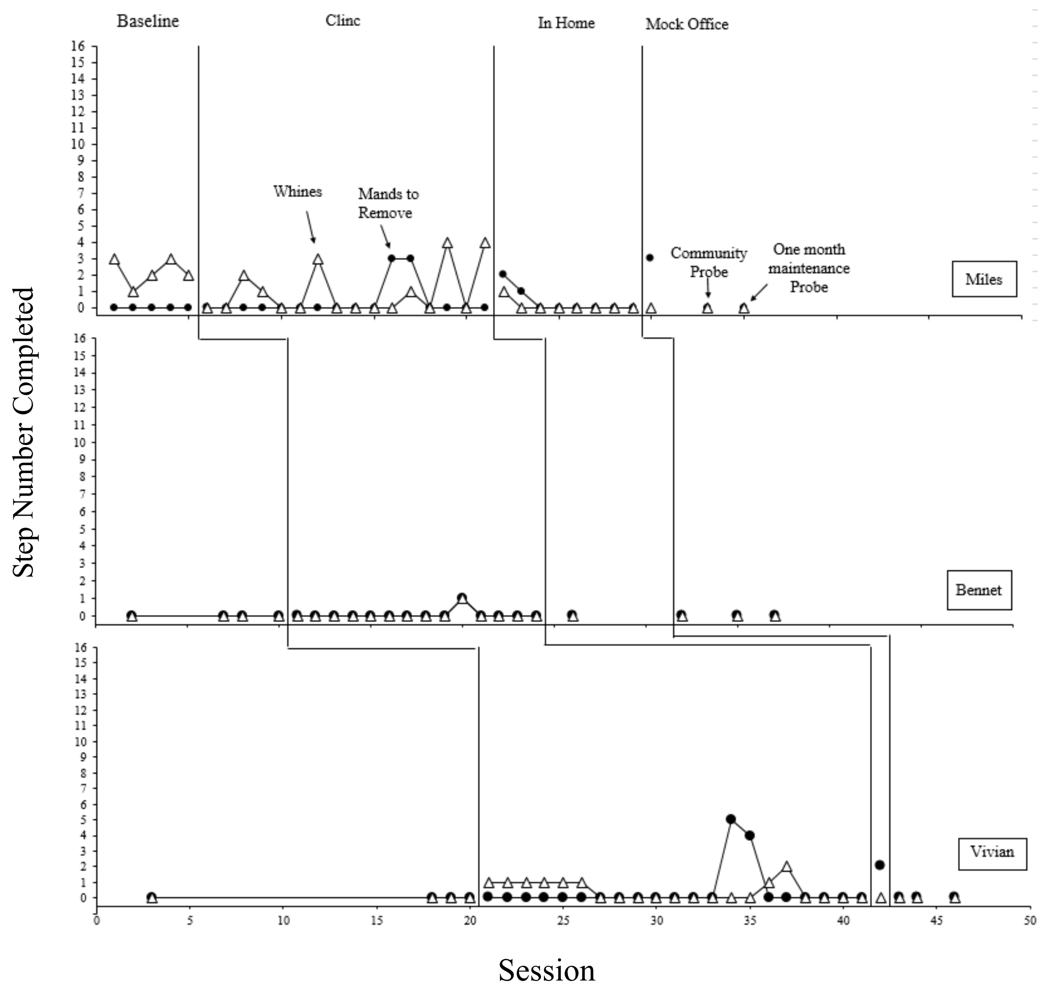

Figure 3

Figure 3. *Step number completed across all settings for Patrick, Chris, and Cameron in Experiment 2. Open data points depict sessions in which mask removal occurred. Closed data points depict session in which mask removal did not occur. Circles depict training sessions, squares depict assessment probes and probes in waiting room, diamonds depict probes in physician's office and are linked to secondary Y axis.*

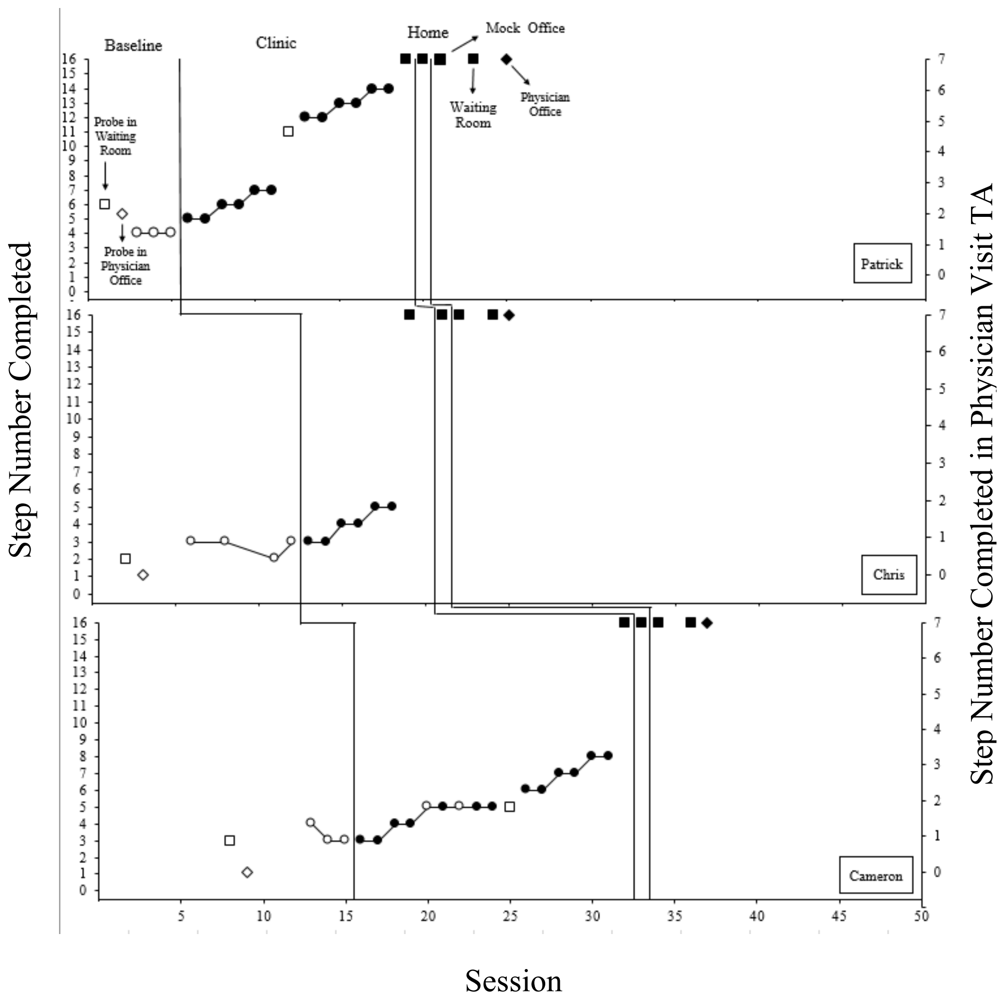

Figure 4

Figure 4. *Frequency of problem behavior of across settings for Patrick, Chris, and Cameron in Experiment 2. Closed circles depict mands to remove the mask and open triangles depict whines.*