Intellectual and Developmental Disabilities

Teaching Healthcare Students and Professionals to Accommodate People with Neurodevelopmental Disorders During Physical Examinations

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Abstract:	People diagnosed with neurodevelopmental disorders (NDD) experience health disparities. To reduce disparities, healthcare students and professionals have repeatedly called for more training to help patients with NDD. To answer these calls, we developed time-efficient training to teach healthcare students and professionals to use evidence-based behavioral interventions during physical examinations to increase the comfort and cooperation of people with NDD. We hypothesized that the training would increase participants' confidence and competency in helping patients with NDD. Participants (n = 173) completed the training in less than 1.5 hr, reported increased confidence after the training, and most participants demonstrated high levels of competency to use the behavioral interventions.

Teaching Healthcare Students and Professionals to Accommodate People with Neurodevelopmental Disorders During Physical Examinations

People with neurodevelopmental disorders (NDD) report having poorer health, attend fewer preventive medical visits, and more frequently experience cardiovascular disease, diabetes, or obesity, compared to people without NDD (Havercamp & Scott, 2015; Reichard et al., 2011). These health disparities may be exacerbated by personal factors such as sensitivities to lights, sounds, or physical contact, fear of medical procedures, or challenges communicating with healthcare professionals (Gillis et al., 2009; Nicolaidis et al., 2015; Zerbo et al., 2015). These factors may predispose some patients to display uncooperative behaviors during medical visits that prevents them from receiving adequate health care. In addition, medical students and physicians frequently report that they lack sufficient knowledge and training to promote the comfort of patients with NDD, resulting in low feelings of confidence or competency to medically care for them (Clarke, 2022; Clarke & Tabor, 2023; Iezzoni et al., 2021; Jensen et al., 2020; Smith et al., 2021; Stillman et al., 2021).

Researchers have studied why medical students and physicians do not feel very confident or competent to medically care for people with NDD. Lee et al. (2023) surveyed all accredited U.S. medical colleges in 2019 and found that less than half of the responding colleges trained students on all six core disability competencies recommended by the Alliance for Disability in Health Care Education (2019). The most frequently cited training barrier was limited curricular time. The amount of training varied across schools, ranging from only one or two 45 – 120 min activities per year to multiple activities that occurred regularly over two years. Critically, one of the least-trained competencies was how to conduct clinical assessments and physical examinations of patients with NDD. This dearth of training also is seen after students graduate.

Clarke and Fung (2022) identified only 17 studies of physician training programs to increase self-efficacy or knowledge in medically caring for people with autism (a prominent NDD). Most studies involved training to better use autism screeners and diagnostic tools. However, no studies evaluated training to help physicians become more confident or competent in conducting physical examinations of people with autism.

To address the lack of training and reports of low confidence and competency to medically care for people with NDD, medical students and physicians have called for more training (Austriaco et al., 2019; Clarke, 2022; Stillman et al., 2021). During medical school, Ankam et al. (2019) called for additional NDD-centered research activities, clinical skills and assessment training, and training on the biopsychosocial care model, which contextualizes NDDs as challenges with functioning that stem from addressable, environmental causes. This aligns with calls from Bowen et al. (2020) and Clarke (2022) to teach medical students about social (i.e., environmental) determinants of health. Ankam and colleagues suggested that these changes could increase the likelihood that students could immediately do core care with patients with NDD upon starting residency, as recommended by the Association of American Medical Colleges (AAMC, n.d.). Researchers also have proposed hiring standardized patients with NDD to help medical students learn clinical skills and promoting contact with people with NDD in community settings to help medical students learn about their experiences and ways to support them (Clarke, 2022; Havercamp et al., 2016). Rotoli et al. (2020) also proposed teaching emergency medicine residents to use visual supports and assistive accommodations during physical examinations to help patients with NDD who have trouble communicating.

Researchers also have proposed that healthcare professionals (i.e., medical students and physicians) should learn to use evidence-based behavioral interventions to accommodate patients with NDD during routine practices like physical examinations. This could increase patients' feelings of comfort and healthcare professionals' feelings of confidence and competence. Nicolaidis et al. (2014) suggested that healthcare professionals learn to survey patients with NDD (or their caregivers) before examinations to learn how to accommodate them. For example, if a surveyed patient states they feel more comfortable when visuals are presented with instructions, the healthcare professional could learn to explain and then show how they will do procedures before doing them (i.e., "tell-show-do"; Allen et al., 1990). Patients also could feel more comfortable if healthcare professionals learned to give breaks. O'Callaghan et al. (2006) showed that pediatric dental patients' disruptive behaviors reduced when they received three brief breaks each minute. Healthcare professionals also could learn to give patients access to activities or incentives. Nordahl et al. (2016) taught 17 children with NDD to lay still during MRI scans by letting them watch preferred videos, which likely distracted them from the loud MRI noises. Cavalari et al. (2013) and Stuesser and Roscoe (2020) showed that giving patients preferred edible items could increase their cooperation during physical examinations. The incentives likely functioned to directly strengthen cooperative behaviors. It also may be necessary for healthcare professionals to learn how to alter physical examination procedures to make them more tolerable. Gillis et al. (2009) developed a 17-step graduated exposure (GE) procedure to reduce discomfort for 18 children with NDD who were disruptive during physical examinations. All children learned to better tolerate examination procedures, and the effects maintained for at least 10 months. Hoang et al. (2024) then extended this work by teaching seven medical students to use an efficacious six-step GE procedure that is simpler to learn and easier to use than the 17-step procedure.

The purpose of this study was to develop and evaluate training for medical students and residents to learn to use evidence-based behavioral interventions during physical examinations of patients with NDD. The interventions could increase a patient's comfort by distracting them, reducing the unpleasantness of procedures, and strengthening behaviors that could help them complete physical examinations. We devised three hypotheses to help us evaluate the training: (a) all participants in a representative sample would produce low pre-training competency test scores to use the behavioral interventions, and would then produce higher post-training scores; (b) most participants in a large sample would score 90% or higher on a post-training competency test to use the behavioral interventions, and (c) most participants would report low confidence in caring for people with NDD before the training and higher confidence after the training. We tested these hypotheses during two different studies. During Study 1, with 12 participants, we conducted pre- and post-training evaluations of competency and confidence. During Study 2, with 161 additional participants, we conducted post-training evaluations of competency and pre- and post-training evaluations of confidence. We also surveyed participants about the social validity of the training.

Study 1

Method

Developing the Training

We developed a 22-min training video with assistance from an advisory board composed of one medical doctor, four medical students, seven advocates with first-hand experience with a physical disability or NDD, and three specialists who worked with people with NDD. During the video, participants received instructions about and viewed models of multiple behavioral interventions. After the video, participants practiced using the interventions during role-plays and received performance feedback. Researchers have used this teaching approach to teach healthcare professionals new skills (Hoang et al., 2024; Matteucci et al., 2022).

The training video instructed viewers how and when to use the following evidence-based behavioral interventions: (a) learning about patients before their visit and directly addressing them during visits (Nicolaidis et al., 2014), (b) telling patients about procedures and using a visual support to depict procedures before completing the procedures (tell, show, do; Allen et al., 1990), (c) offering patients breaks after each procedure (O'Callaghan et al., 2006), (d) giving patients preferred items or activities to use throughout the examination (Nordahl et al., 2016), (e) using a simplified, three-step graduated exposure (GE) procedure with patients during challenging procedures (Gillis et al., 2009; Hoang et al., 2024), and (f) giving patients incentives if they participated during the three GE steps (Cavalari et al., 2013; Stuesser & Roscoe, 2020).

Participants and Setting

To evaluate the training, we recruited 12 participants: ten medical students (seven first-year, one second-year, and two fourth-year) and two first-year medical residents. We observed all participants in urban, academic-affiliated settings. The students attended a month-long rotation at a community or hospital-affiliated clinic that specialized in providing care to patients with NDD. The residents attended a month-long rotation at two hospital-affiliated centers specializing in developmental pediatrics and autism. All participants volunteered to participate in the training as part of their rotation experiences and were evaluated individually over a four-month period.

All 12 participants provided sex demographics: 67% identified as female and 33% as male. Only 10 participants provided race and ethnicity demographics: 70% identified as White, 20% as Black, and 10% as Middle Eastern or North African. Only one student and one resident (16.7% of the sample) reported that they had previously received training (an average of 4 days) to provide medical care to patients with NDD. Notably, the low number of participants with previous training corroborates Lee et al.'s (2023) findings that NDD-centered training is uncommon during medical school. Six participants (50%) reported that they have a family member who identifies with having or living with a disability.

Our institutional review board classified the study as minimal risk. We did not collect personally identifying information and participants could opt out of including their data. We assigned all participants randomized identifiers to relate their completed measures.

Experimental Design

To evaluate competency to use the behavioral interventions, we used a pre- and post-training design. From each participant, we collected one pre-training measure of competency, and after the training, one or more post-training measures of competency. This data enabled us to determine if a representative sample of medical students and residents could have already been competent in using the interventions before they experienced this training, which would represent a severe threat to internal validity.

To evaluate confidence in caring for patients with NDD, we also used a pre- and post-training design. Participants completed a pre-training confidence survey before completing a pre-training competency test or viewing the training video. Participants then completed a post-training confidence survey after completing their final post-training competency test.

Measurement and Interobserver Agreement

We conducted competency tests to measure each participant's competency to use the interventions from the training video. To conduct a competency test, we directly observed each participant while they completed a mock physical examination of an experimenter who was trained to role-play as a patient (see *procedures* for more information about patient training).

During the competency test, trained experimenters used their laptop computer or cellular phone to record data on Qualtrics (https://www.qualtrics.com) about the participant's correct use of each intervention. We developed this Qualtrics-based data sheet by observing physicians conduct physical examinations to determine the general sequence of an examination. Then we identified parts of the examination during which time it would be ideal for healthcare professionals to integrate the behavioral interventions. For example, the intervention *tell, show, do* should be used at the start of each procedure, and *breaks* should be offered after each procedure. In sum, the Qualtrics-based data sheet described 23 opportunities for the participant to use the interventions during a mock physical examination (see Table 1). To teach experimenters to reliably measure competency, we had them watch three examples of mock physical examinations while using the Qualtrics-based data sheet to score the physical examiner in each examination. The first author also scored the same three mock examinations. We considered an experimenter accurate in measuring competency if they obtained 90% or greater interobserver agreement with the first author on at least two of the three mock examinations. To calculate interobserver agreement, the first author compared the per-opportunity agreement between the first author's and each experimenter's three mock examinations. Agreement occurred when the first author and experimenter identically scored the same use of an intervention during a given opportunity during each mock examination. For each mock examination, the first author calculated the percentage of agreement by summing all agreements, dividing by 23 (total number of opportunities), and multiplying by 100. All experimenters learned to measure competency reliably. Experimenters collected interobserver agreement for 33.3% of participants' competency tests, and the mean interobserver agreement was 94.3% (range, 89.2% - 100%).

To measure confidence in caring for patients with NDD, we extended research by Nicolaidis et al. (2021) and Hoang et al. (2024) to create a 9-item confidence survey that participants completed before and after training. For each item, participants rated their confidence on a scale of 0 – 10 (10 = extremely confident) to perform tasks during a physical examination with patients with NDD. In specific, the survey asked participants about their confidence to (1) perform the physical exam, (2) diagnose medical issues, (3) address medical issues, (4) communicate with the patient, (5) ensure the patient's comfort, (6) encourage the patient's cooperation, (7) identify needed accommodations, (8) make needed accommodations, and (9) address challenging behavior.

To evaluate social validity, after completing the training, participants scored the following questions on a scale of 0 – 10 (10 = extremely helpful or extremely feasible): (a) how helpful do you think the training was in teaching you about interventions for people with NDD?; (b) how helpful do you think the reference booklet was in helping you do your competency test?; and (c) how feasible do you think it would be to use the interventions during patient visits?

Procedures

Before viewing the training video, participants took around 5 min to complete the pre-training confidence survey. Then, they took about 10 min to complete a pre-training competency test. Before each competency test, we described and showed the participant (a) an otoscope, (b) a stethoscope, (c) an A4-sized visual support with depictions of standard physical examination procedures, (d) a stress ball that we told the participant "could distract the patient," (e) a bag of ten, 2.54 cm wooden cubes that we told the participant "represents items that could incentivize cooperation" and, (f) a four-page, double-sided, pocket-sized reference booklet that we told the participant "could help you perform the exam." The reference booklet depicted flow charts and limited instructions that described when and how to use the interventions. Next, we asked participants to start their pre-training competency test by saying “use the materials and reference booklet to conduct a physical examination in which you first check the patient’s ears and then check their heart.” The participant then completed a mock physical examination with an experimenter trained to follow a one-page script. This script contained detailed instructions for how the patient should respond to the participant conducting the physical examination. While the participant completed the competency test, one experimenter (or two during 33.3% of competency tests on which we evaluated interobserver agreement) used the Qualtrics-based data sheet to measure the participant’s intervention use. We did not provide performance feedback after any pre-training competency tests.

Next, participants watched the 22-min training video to learn about health disparities experienced by patients with NDDs and interventions to promote their comfort during physical examinations. In the final part of the video, participants viewed three examples of mock physical examinations in which experimenters demonstrated using the interventions. While viewing the mock physical examinations, we asked participants to actively learn by indicating the experimenter’s intervention use on a Qualtrics-based version of the reference booklet. To indicate intervention use, participants tapped (on their phone) or clicked (on their laptop) on the flow charts and limited instructions, which caused checkmarks to appear on the clicked or tapped parts. We thought the physical similarity between the Qualtrics-based reference booklet and the physical reference booklet could help participants learn to use the physical reference booklet during their competency test. After each mock physical examination example, we described errors the experimenter made and gave rationales for why it is vital to use the interventions.

After participants finished the training video, we assessed their post-training competencies to use the interventions. Each post-training competency test took about 5 min to conduct. The post-training competency test procedures were identical to the procedures described for the pre-training competency test except for two minor changes: First, before the post-training competency test, we reminded participants to use the reference booklet and demonstrated how they could refer to it during the competency test by holding it in hand or placing it on a table. Second, after the post-training competency test, we gave each participant about 30 s of performance feedback. The feedback included three statements highlighting correct intervention use (e.g., “You gave the perfect number of incentives”) and up to three statements about incorrect intervention use (e.g., “You forgot to offer a break after the ear exam; please offer breaks in case the patient needs one”). We provided this feedback so that all participants could understand how they performed during their post-training competency test. We also provided the feedback in case any participant needed to take a second post-training competency test. We asked a participant to take a second post-training competency test if they made three or more errors during their first post-training competency test. After completing the post-training competency test(s), participants completed the post-training confidence survey and answered the social validity questions.

Results

We used GraphPad Prism 9.5.0 (https://www.graphpad.com) to compute descriptive statistics and conduct one-tailed, paired-sample t-tests to compare participants’ pre- and post-training competency test scores and confidence ratings. We used one-tailed t-tests because all the hypotheses we planned to test were directional (i.e., competency and confidence scores were always expected to increase because of the training). We also used Prism to graph and visually analyze participants' competency test scores and confidence ratings. We included graphs so readers could see the training effects for all participants. See the top panel of Figure 1 for a graph of participants' competency test scores and confidence reports.

Competency to Use the Interventions. As hypothesized, the 12 participants produced a low mean pre-training competency test score of 34.5% (n = 12, SD = 9.4, range = 16.7% – 52.2%) which increased to 86.4% after the training (n = 12, SD = 15.1, range = 53.6% – 100%) – a statistically significant increase (t = 12.2, df = 11, p < .0001, 95% CI [42.5 – 61.2]). All participants made 11 or more errors on their pre-training test. Eight participants (66.7%) made 0 – 2 errors to produce a score of 90% or higher during their post-training test. Four participants (33.3%) made three or more errors to produce a score of less than 90% during their post-training test. After receiving feedback, the four participants took a second post-training test on which they made two or fewer errors. Replacing their first scores with their second scores increased the mean post-training score for the 12 participants to 95.1% (n = 12, SD = 4.0, range = 90.5% – 100%). One other interesting finding was that medical residents' mean pre-training test score was only slightly higher than medical students' mean score (37% for residents versus 34% for students). This is relevant because the residents reported having five years of training, while students reported having only one, two, or four years of training.

Confidence to Care for Patients with NDD. As hypothesized, the 12 participants reported a low mean pre-training confidence score of 3.9 out of 10 (n = 12, SD = 1.6, range = 0 – 6.1), and a higher mean post-training confidence score of 7.3 (n = 12, SD = 1.1, range = 5.9 – 9.4). Confidence scores statistically significantly increased for all participants (t = 7.5, df = 11, p < .001, 95% CI [2.4 – 4.4]).

Social Validity of the Training. Participants reported that the didactic training helped them learn to use the interventions (mean score of 8.3 out of 10), the reference booklet helped them complete their post-training competency test (mean score of 8.3 out of 10), and that the interventions would be feasible to use during a medical visit (mean score of 8.4 out of 10). Five participants (33%) also gave open-ended feedback. Of those, four gave only positive feedback (e.g., "Really enjoyed having step-by-step reference booklet when approaching these types of visits.", "I think the training video was brief enough, and practical.", and "Much needed for all physicians.") and one gave positive and constructive feedback (e.g., "Great skills! Love the way information was presented and incorporated practice throughout. Slightly repetitive at points.").

Study 2

Method

The results from Study 1 guided our decision to conduct Study 2. Study 2 was a large-scale feasibility study in which we used the video training and some adapted methods from Study 1 to determine if the training could be used with a larger number of participants. Our institutional review board classified Study 2 as minimal risk, we assigned participants randomized identifiers instead of collecting personally identifying information, and participants could opt out of including their data.

Participants and Setting

We recruited 161 participants: 142 medical students (22 second-year, 120 third-year) and 19 first-year medical residents. The students attended two local, urban, medical schools. At one college, we provided the training on a single day, embedded in a pre-clerkship course that focused on serving patients with a broad range of disabilities. At the second college, we provided the training on a single day, embedded in a clerkship course about the social determinants of health. Students mandatorily participated but could opt out of including their data. The residents attended the same sites as in Study 1 and were evaluated over a two-month period.

Only 127 participants provided sex demographics: 65% identified as female, 34% as male, and 1% as non-binary. Only 110 participants provided race and ethnicity demographics: 41% identified as White, 35% as Asian, 9% as Black, 11% as Hispanic, Latino/a/é, or Spanish, and 4% as Middle Eastern or North African. Twenty-seven participants (16.8%) reported having previous training to medically care for patients with NDD. Of those, 16 described how much training they received. For 12 of the 16, the average amount of training was 11.6 days. Three participants reported they had received one year of training, and one participated reported they had ten years of training. Twenty-eight participants (17.4%) reported that they have a family member who identifies with having or living with a disability.

Experimental Design

We used a post-training-only design to evaluate competency to use the behavioral interventions. We selected this design for several reasons: First, the two medical schools only gave us two hours for the training, which was not enough time to conduct pre-training competency tests. Also, medical students and residents already report having insufficient NDD-centered training (Clarke, 2022; Clarke & Tabor, 2023; Iezzoni et al., 2021; Jensen et al., 2020; Smith et al., 2021; Stillman et al., 2021), and researchers have found evidence to support these reports (Lee et al., 2023). Finally, all participants from our Study 1 produced low pre-training competency test scores, which further supports a lack of NDD-centered training during medical school. Due to these factors, we expected that participants in Study 2 would not have learned to use the behavioral interventions before experiencing the training.

To further support this expectation, we compared the participants in both studies to determine if the Study 1 participants were a representative sample of Study 2 participants. The percentage of medical students and residents were similar in both studies (Study 1: 83.3% students and 16.7% residents; Study 2: 88.2% students and 11.8% residents), as was the percentage of participants who reported having previously received training to care for patients with NDD (Study 1: 16.7% of participants; Study 2: 16.8% of participants). Finally, recall that in Study 1, the medical residents' pre-training competency test score (37%) was similar to the medical students' score (34%), despite the residents having had more training. If medical residents from Study 1 had not yet learned to use the interventions taught in the training, it seems plausible that the second- and third-year students in Study 2 also might not yet have learned.

To evaluate confidence in caring for patients with NDD, we used a pre- and post-training design in which participants completed a pre-training confidence survey before viewing the training and then completed a post-training survey after completing a post-training competency test. However, 52 participants chose not to complete the pre- and post-training surveys.

Measurement and Interobserver Agreement

Measurements of competency, confidence, and social validity were collected as described in Study 1. Interobserver agreement also was calculated as described in Study 1 and was collected for 52.1% of competency tests. The mean agreement was 93% (range, 64% - 100%).

Procedures

First, we asked all participants to take about 5 min to complete the confidence survey. All participants then watched the 22-min training video in a large group and used the Qualtrics-based reference booklet to indicate what behavioral interventions were used during the three mock physical examinations from the training video. Afterward, we formed the participants into smaller groups of 10 or fewer to evaluate their competency one participant at a time. To evaluate competency, we used identical procedures as in Study 1 and included two additional procedures. First, we asked participants who were not currently taking a competency test to observe the test-taking participant. While observing the test-taker, the non-testing participants used the Qualtrics-based reference booklet to indicate the test-taker's intervention use, exactly like they did on the three mock physical examinations from the training video. Second, to reduce the need for one experimenter, we trained one participant from each of 18 different groups to use the one-page patient script. This training took less than 5 min. The trained participant then role-played as the patient with all other participants in their group during their competency tests. Each post-training competency test took about 5 min to complete. All participants (except those we trained to be a patient) completed one post-training competency test and received about 30-s of feedback after the test. After all participants completed one test, we asked them to complete the post-training confidence survey and to answer the social validity questions. Participants took about 1.5 hr to complete the training.

Results

As in Study 1, we used Prism to compute descriptive statistics, conduct paired-sample t-tests and graph competency test scores and confidence ratings. See the second through fifth panel of Figure 1 for participants' graphed competency test scores and confidence reports.

Competency to Use the Interventions. The mean post-training competency test score of all participants was 91.2% (n = 161, SD = 11.1, range = 34.8% – 100%). One hundred and eleven participants (68.9% of the sample) produced scores of 90% or higher, which supports our hypothesis that most participants would score 90% or higher on their post-training test. It is interesting to recall that in Study 1, 66.7% of participants also scored 90% or higher on their first post-training test.

Confidence to Care for Patients with NDD. Note that we could not analyze confidence for the 52 participants (32.3% of the sample) who chose not to complete the confidence surveys. As hypothesized, participants reported a low mean pre-training confidence score of 4.9 out of 10 (n = 109, SD = 1.9, range = 0 – 9.8), and a higher mean post-training score of 7.4 (n = 109, SD = 1.8, range = 1.8 – 10) – a statistically significant increase (t = 13.5, df = 108, p < .001, 95% CI [2.1 – 2.8]). Confidence scores increased for 105 out of 109 participants (96.3% of participants).

Social Validity of the Training. Participants reported that the didactic training helped them learn to use the interventions (mean score of 7.9 out of 10), the reference booklet helped them complete their post-training competency test (mean score of 8.3 out of 10), and the interventions would be feasible to use during a medical visit (mean score of 7.9 out of 10). Twenty participants (12.4%) gave feedback. Of those, 10 gave only positive feedback (e.g., "Loved the interactive nature of the session!", "Very helpful suggestions. Appreciate the booklet for future reference."), and the remaining 10 gave a mix of positive and constructive feedback (e.g., "Liked the skills. Training was a little repetitive. Could change up how the patient responds or what they need.") or only constructive feedback (e.g., "[The training was] too tedious and nit-picky," and "[The interventions] didn't feel particularly realistic for day-to-day visits").

Discussion

We developed training to teach healthcare professionals to use evidence-based interventions to promote the comfort of people with NDD during physical examinations. To study the effects of the training, during Study 1, we first used a pre- and post-training design to demonstrate that 12 participants could not competently use the behavioral interventions before training but could immediately after the training (eight participants) or after receiving performance feedback (four participants). Importantly, Study 1 replicates previous findings that healthcare professionals do not use similar behavioral interventions before receiving training but do use them after training (Hoang et al., 2024; Matteucci et al., 2022). After determining that the training was efficacious in increasing participants' competency to use the interventions, we conducted Study 2. During Study 2, we used a post-training only design to study how the training influenced the competency of 161 additional participants. We found that a similarly high percentage of participants in Study 2 and Study 1 demonstrated immediate competency to use the interventions. We also found that across both studies, all but four participants reported increased confidence to medically care for people with NDD. All participants completed the time-efficient training in less than 1.5 hr.

Our results increase our confidence that the training is truly responsible for participants producing their post-training competency test scores. All 12 Study 1 participants made 11 or more errors on their pre-training competency test and then after training, eight out of 12 made two or fewer errors (i.e., produced scores of 90% or better). We can conclude that those participants' high competency test scores are a direct effect of viewing the training video. Also, an almost identical percentage of participants in Study 1 (66.7%) and Study 2 (68.9%) scored 90% or higher on their first post-training competency test. This similar mean level of post-training competency seems to reinforce our hypothesis that the Study 1 participants were a representative sample of the Study 2 participants. Therefore, if researchers or medical educators use this training, we recommend that they reserve extra training time so participants can receive feedback after a low-scoring competency test and then retake the test, as we did with four of the

Study 1 participants. If we had the time to do this with Study 2 participants, we think many more of them would have displayed high levels of competency.

One critique of the results might be that only about two-thirds of participants produced post-training competency test scores above 90%. However, note that we arbitrarily selected this 90% criterion. We are unsure if scores of 91.3% (two errors on the 23-item competency test) are significantly better, either clinically or statistically, than scores of 87% (three errors) or 82.6% (four errors). If we had instead selected an 80% criterion, 85% of participants would have met this criterion on their first post-training competency test. Also consider that if a participant systematically forgot to use *one* behavioral intervention but did all other parts of their competency test perfectly, they would likely produce a score of less than 90%. For example, forgetting to offer all breaks would produce a score of 87%. Forgetting to offer all incentives: 82.6%. Forgetting to use GE: 65.2%. And yet, 37.6% of participants scored a 100%. We think this means that the competency test is fair, but we are sure that researchers could find ways to improve it. As a final appeal, recall that participants in Study 1 produced a mean pre-training competency test score of 34.5%. All participants produced a post-training competency test score that was higher than this mean pre-training score. Therefore, an optimistic interpretation of the competency test scores could be that all participants benefitted from the training, though some more so than others. To improve participants' abilities to immediately produce high post-training competency test scores, researchers should study factors that reduce the effectiveness of this training. For example, some Study 2 participants reported the training was repetitive or tedious. Perhaps those participants became so disengaged during the training that they failed to learn how or when to use the behavioral interventions, resulting in low competency test scores. Researchers could study this by modifying the training to improve participant engagement and then measuring whether a greater percentage of participants produce higher competency test scores.

One limitation of this research was that we only conducted pre-training competency tests with 12 participants in Study 1. We could not collect pre-training competency measures with Study 2 participants due to limited time. The lack of pre-training competency scores for the 161 participants in Study 2 makes it challenging to determine the extent to which the training influenced their post-training competency scores. For example, some Study 2 participants may have produced high post-training competency scores because they previously learned to use the interventions (i.e., an extra-experimental history confound). Although this is possible, we do not think it can adequately account for participants' scores. Recall that two participants (16.7%) in Study 1 reported having previous NDD-centered training (in the top panel of Figure 1, these are participants 2 and 5). However, participant 2 scored a 52.2% and participant 5 scored a 28.6% during their pre-training competency test. If they had learned to use the behavioral interventions during their previous NDD-centered training, we would have expected them to produce higher pre-training competency test scores. Also recall that only 16.8% of participants in Study 2 reported having previous NDD-centered training. This low percentage of previous training in Study 1 and Study 2 corroborates findings that NDD-centered training is uncommon during medical school, which suggests that few, if any Study 2 participants would have already learned to use the behavioral interventions before the training. We also do not think that Study 1 participants could have affected Study 2 participants' competency scores (for example, by telling them about the training or giving them access to training materials). The Study 1 medical students were in year 1, 2, and 4 of medical school, but the Study 2 medical students were in year 3. Also, we trained the Study 1 medical students at clinics but trained the Study 2 medical students at medical schools. Finally, the residents in Study 1 only rotated at the clinical sites for about 4 weeks and so would have left the sites by the time we recruited the Study 2 residents from the same sites. To make these explanations unnecessary, researchers should collect pre-training competency measures with a larger percentage of participants. This would serve to increase confidence in the effects of this training. Medical educators at medical schools could most easily collect these measures. For example, during pre-clerkship, medical educators could evaluate students' pre-training competency to use the interventions, provide the training, and then test students' post-training competency.

Another limitation is that we did not test participants' abilities to use the interventions with real patients who are diagnosed with NDDs. Medical educators could extend this research by first providing this training to medical students and then evaluating their abilities to use these interventions during standardized patient encounters with patients with NDD. Note that this may not be easy. Researchers have long recommended that medical educators include standardized patients with NDD during medical school training (Brown et al., 2010; Long-Bellil et al., 2011), however, this practice does not appear to be common (Lee et al., 2023). Alternatively, if standardized patients with NDD are unavailable, medical educators could coordinate with preceptors in clinics that serve patients with NDD. The preceptors could evaluate students' abilities to use interventions with patients with NDD, either by direct observation (as done in this study) or by interviewing students after they physically examine a patient with NDD. It may be much easier for preceptors to interview students than to directly observe them, so researchers could extend this work by developing a simple data sheet for attending physicians to collect these data. Another related limitation is that we did not assess how well participants maintained their ability to use the interventions over time. Medical educators could extend this research by repeatedly assessing intervention use throughout medical school. If intervention use declined over time, it could inform the need for periodic booster training. Proactively programming for maintained use of these interventions could enable students to immediately do core patient care activities with patients with NDD during residency, as the Association of American Medical Colleges recommends (AAMC, n.d.).

One final limitation was the high trainer-to-participant ratio. We required two or, at times, even three trainers for each group of 10 participants: one trainer to perform the patient role, one trainer to evaluate competency, and for about half of groups, one extra trainer to collect data for interobserver agreement. If a medical school or resident training site does not have enough personnel to serve as trainers, they will be limited in their ability to deliver this training. To reduce the need for one trainer, with 18 groups, we trained one participant to use the patient script so that they could perform the patient role for other participants in their group. That means that in these groups we only needed one or two trainers. We did not observe participants make errors when using the patient script, which suggests that participants can learn to perform the patient's role. Based on our success with training participants to perform the patient's role, we think it also could be possible to teach participants to use the Qualtrics-based data sheet to evaluate their group member's competencies to use the behavioral interventions. If participants served as both patients and as data collectors, medical educators would be able to implement this training with minimal trainers. Researchers should systematically replicate our methods to find ways to reduce the need for trainers and then study how the changes affect the training outcomes.

As of 2021, about 6 million children in the United States were diagnosed with an NDD (Zablotsky et al., 2023). This means that our approximately one million physicians are outnumbered six-to-one. Given the health disparities faced by people with NDD and the dearth of training for healthcare professionals to learn to better accommodate them, we believe that this time-efficient training could help address the training gaps. We call on researchers and medical educators to replicate and study this training with more participants and to consider our recommendations to improve the training methods and outcomes. Please contact the first or second authors for a link to our training video and free access to all materials needed to use this training.

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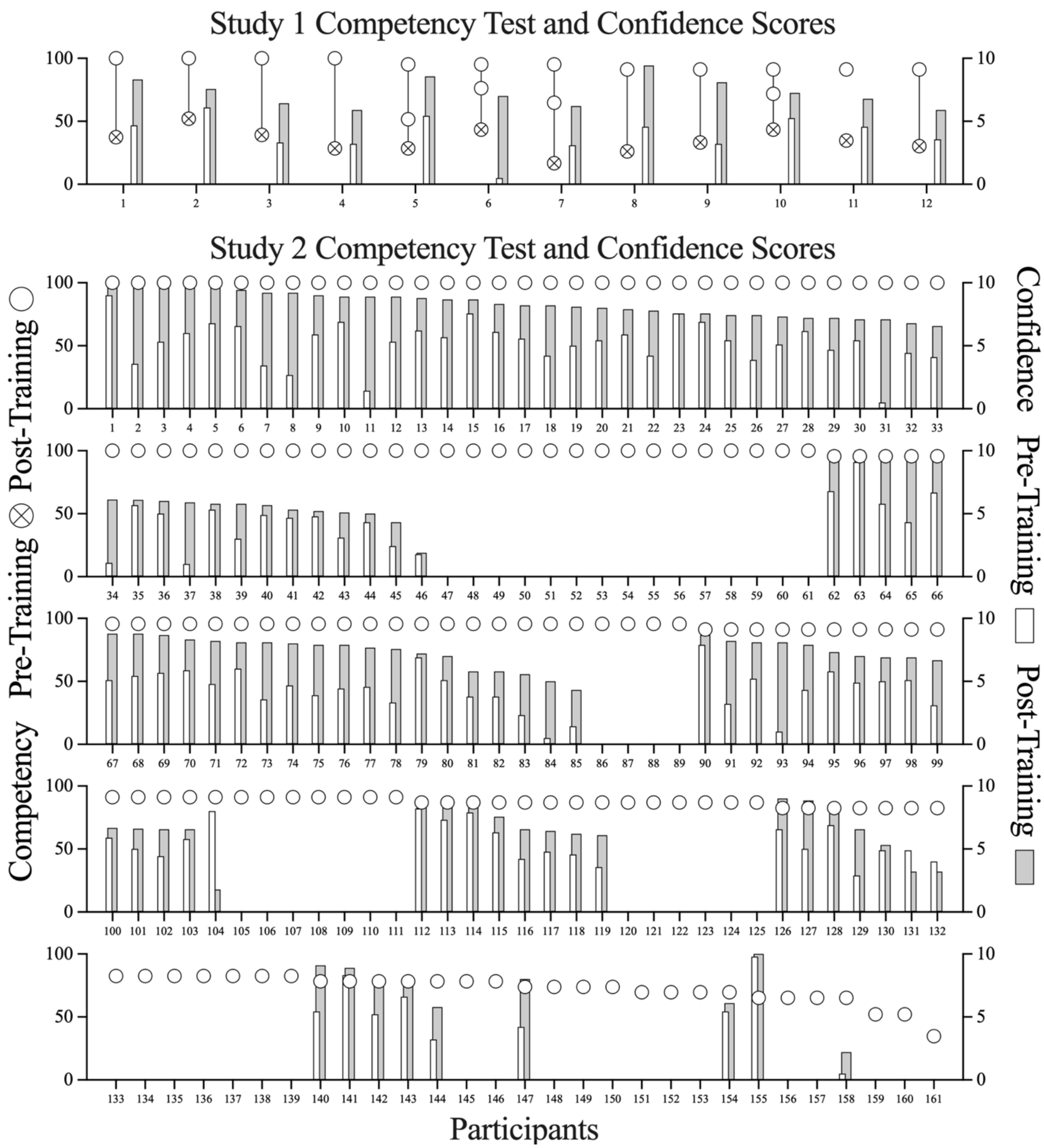
Figure 1

Study 1 and 2 Competency Test and Confidence Scores



Note. Competency test scores are graphed on the left y-axis, sorted in decreasing order. A circle with an “X” indicates a pre-training competency test score and an open circle indicates a post-training competency test score. Confidence ratings are graphed on the right y-axis. White bars indicate pre-training confidence ratings, and gray bars indicate post-training confidence ratings.

Table 1

Qualtrics-Based Data Sheet

For each question, please check off what the participant did or leave blank what they did not do.

At the start of the exam, the participant:

- Greeted the patient
- Introduced themselves
- Explained the purpose of the visit
- Gave patient the distraction item

During the ear exam, the participant is supposed to use tell-show-do. They:

- Told and showed using the visual support
- Tried to do the ear exam

During the ear exam, the participant is supposed to show the otoscope from 2 ft away. They:

- Showed the otoscope from 2 ft away
- After showing from 2 ft away, gave incentive item
- After showing from 2 ft away, gave praise or thanks
- After showing from 2 ft away, gave choice of a break

During the ear exam, the participant is supposed to show the otoscope from 1 ft away. They:

- Showed the otoscope from 1 ft away
- After showing from 1 ft away, gave incentive item
- After showing from 1 ft away, gave praise or thanks
- After showing from 1 ft away, gave choice of a break

During the ear exam, the participant is supposed to try to do the ear exam again and move to the heart exam when the patient is not cooperative. They:

- Tried to do the ear exam again
- After trying, immediately stopped the ear exam and moved to the heart exam

During the heart exam, the participant:

- Told and showed using the visual support
- Did the heart exam
- After doing the heart exam, praised or thanked patient
- After doing the heart exam, gave choice of a break

At the end of the exam, the participant:

- Thanked the patient for participating
- Said "goodbye"
- Gave the patient extra incentives